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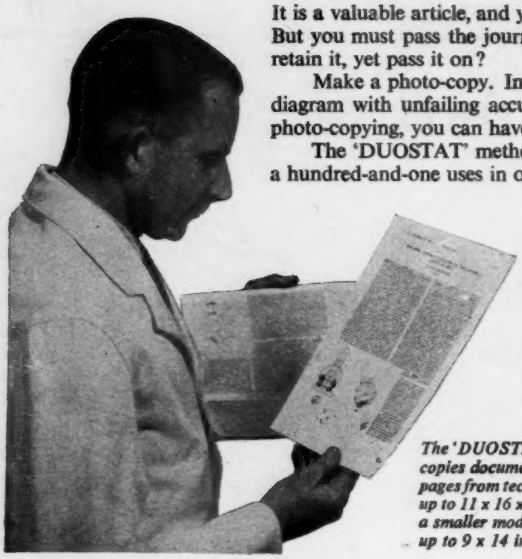

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NUCLEAR POWER AND ITS DEVELOPMENT IN BRITAIN

THE reference in the recently issued annual report of the Department of Scientific and Industrial Research to the European Organization for Nuclear Research is comparatively brief; but it is clear that the scale of the British contribution in this field is growing. The Advisory Council notes in this report that impressive progress has been made since the inter-government convention came into force in October 1954, that the staff of the Organization is now between two and three hundred and that some research is already in progress. In the year covered by this report, Great Britain's contribution was almost £360,000; £520,000 was provided in the Estimates for 1955–56; while those for 1956–57 provide £930,000, or more than 10 per cent of the Department's gross budget of nearly eight and a half million pounds. Besides this, there are the Department's grants to universities for nuclear physics research, which are running at the rate of a quarter of a million a year, and there is the proportion of the vote for atomic energy which is spent on research and development. For 1955–56 and 1956–57 the vote itself is a little more than £54 million and £68 million, respectively; but the Civil Estimates give no information as to expenditure on research and development. It can only be assumed that approximately £2 million in 1955–56 and £2·5 million in 1956–57 which is being expended on work by industry and at universities is for such purposes.

It is clear, therefore, that neither the annual report of the Department of Scientific and Industrial Research nor the Civil Estimates gives the scientific and technical world sufficient information for a sound judgment as to whether or not the scientific and technical effort in Britain in the nuclear energy field, either in research or in development, is in balance with other activities and resources of the country. When all allowance is made for the extent to which security considerations make it imprudent to disclose the nature and magnitude of that effort where it relates to defence, maintenance of secrecy is detrimental to the efficient use of resources in the development of nuclear energy for peaceful purposes and to effective co-operation with industry. Nor is it reasonable to withhold information which would enable better judgment to be formed as to the scale of the British contribution to European co-operation in that field, when that contribution exceeds 10 per cent of the total budget of the main institution in Britain for the administration of Government support for research.

Concern in this respect might be less were it apparent that the Office of the Lord President of the Council was being appropriately strengthened to discharge its growing responsibilities for the general supervision of the nation's scientific effort. The Civil Estimates for 1956–57 disclose no such signs. The staff of nine remains unchanged, and the estimate of £14,345 compares with £13,370 in 1955–56 and with a staff of eighteen and vote of £19,400 for the presumably subordinate Atomic Energy Office, and a staff of twenty-three and vote of £28,620 for the University Grants Committee. The unsatisfactory situation which leaves the House of Commons with no minister or parliamentary under-secretary directly responsible for the nation's vast interests in science and technology persists, and the Bill to change the administration of the Department of Scientific and Industrial Research does not touch this formidable problem, which has recently been the subject of 'questions' in the House.

Quite apart from this question of the balance and effective co-ordination of the research effort of Britain, it is not surprising, therefore, that the Government should have been pressed for more information as to its attitude to European co-operation in the development of nuclear energy for peaceful purposes and to the industrial development of nuclear energy in Britain itself. On the first point, the Lord Privy Seal, Mr. R. A. Butler, on February 29, declined to say anything about the discussions then proceeding at the ministerial meeting of the Council of the Organization for European Economic Co-operation in Paris, nor did a bulletin issued that week by the Information Division of the Treasury add to Mr. Selwyn Lloyd's statement of February 15. Although no ministerial pronouncement has yet been made, it would seem that at that meeting the Foreign Ministers of the six countries constituting Euratom avoided discussions in February. The Organization for European Economic Co-operation, however, comprises eleven countries, including Britain as well as these six, and there appears to be no reason why it should wait on the six before determining its part in the development of nuclear energy.

The meeting of Ministers in Paris in the first week in March appointed a special committee which is to formulate detailed proposals during the next three months on five specific questions. Two of these relate to procedure. The committee is to make recommendations on the functions of a steering committee for nuclear energy which is envisaged as the permanent organ of the Organization for European Economic Co-operation for co-ordinating and directing European co-operation in this field, and also on the means of co-ordinating the action of existing organizations, such as Euratom. This committee is also to report on the nature of security controls required to prevent the diversion of fissile material, on the joint undertakings to be sponsored by the Organization for European Economic Co-operation, and on the steps to be taken to keep intra-European trade in nuclear equipment and materials as free from restrictions as possible. The committee was specifically authorized to consult the United States Government about the implications of the American offer to sell or lease 20,000 kgm. of uranium-235 for use in research and power reactors in countries outside

the United States not at present producing it themselves.

These are sensible decisions; but what needs to be emphasized is that bold decisions are required and that they cannot be postponed if Western Europe is to reap the advantages which nuclear energy can offer. Such questions as whether nuclear energy is to be developed for peaceful purposes only, whether the proposed Commission shall have supranational powers or not, and whether it shall be the sole owner of fissile material cannot be evaded indefinitely. The answers to be given determine alike the form of the organization itself and the extent of the support which it receives from different countries. Moreover, they may react on the form which developments take in particular countries, and for that reason alone the growth of Euratom may prove to be closely related to the way in which the development of nuclear energy proceeds in Britain. One such point is in regard to the control of private industrial development, on which Mr. Butler was also questioned on February 29. Mr. Butler replied that since at present the essential nuclear fuel can be obtained only from the Atomic Energy Authority, the administrative control through the Authority is adequate for the Lord President of the Council to carry out his duties under the Atomic Energy Act; however, the Lord President is considering to what extent the growing interest of private industry in this field would call for the exercise of powers available under the Atomic Energy and Radioactive Substances Acts, 1946–54, to supplement or replace existing arrangements. Pressed further, Mr. Butler said that he is satisfied that the powers under these Acts are adequate.

A further statement on the relation between the State and private industry in the development of nuclear energy was made by Mr. Butler on March 14. In reply to specific questions from Mr. W. N. Warbey, he said that the current civil allocation of plutonium and uranium-235 is sufficient for the present programme of more advanced types of civil power and research reactors, and that in spite of the main limiting factor of the shortage of suitably qualified scientists and engineers both in the Atomic Energy Authority and in industry, no radical departure from the nuclear power programme outlined in the White Paper of February 1955 is contemplated. Mr. Butler said that the Government considers that the relation between the State and industry in this field should be one of close partnership subject to the maintenance of a proper degree of control by the Government; much of the necessary research, development and production will have to be carried on by the Atomic Energy Authority, if only because of the high cost of the capital facilities required. Some activities, such as the import and processing of uranium and the separation of uranium-235 in the diffusion plant, must remain responsibilities of the Authority alone, because they concern defence as well as civil requirements, and the nuclear fuel required by industry would be provided on loan. On the staff question, he said afterwards that 3,465 out of 4,202 established non-industrial Civil servants have accepted offers of employment and signed contracts with the Authority, and that the Authority's total staff is at present about 22,000.

For the rest, the Government hopes that both private and nationalized industry will enter as rapidly and extensively as possible on the commercial application of nuclear energy. The nuclear power stations to be built in Britain for the production of electricity will be designed and constructed by private industry —and private industry, not the Authority, will fulfil export orders. The Authority will give industry the maximum of help which its technical resources permit, subject to safeguarding two points: first, the Authority should, where appropriate, be paid for commercially valuable information (including the use of patents owned by the Authority) which has been acquired at considerable expense; and, second, that firms are not enabled to use the assistance afforded by the Authority to build up exclusive rights for themselves.

The access agreements made by the Authority with private firms contain provisions to cover these points. Such agreements naturally vary according to the nature of the transaction, and Mr. Butler pointed out that it would not be consonant either with sound commercial practice or with the Authority's freedom to manage its day-to-day business on commercial lines that it should be required to publish such details, or that the Lord President should be answerable for them. In an earlier answer on February 22, Mr. Butler had indicated that the terms for the loan of nuclear fuel will cover the cost of fabricating the fuel elements, a percentage of the total cost of the fuel, including a part for research and development, the cost of fuels spent in running the reactor, and the cost of re-processing spent fuel elements. On March 21, Mr. Butler declined to give further details about particular agreements, but said that payment for the use of patented inventions would depend on the extent to which patents owned by the Authority were in fact used, and that the Lord President does not at present intend to make an order providing that the acquisition, production or use by private industry of nuclear fuels or plant for the production or use of nuclear energy will be permitted only under official licence. It may, however, be necessary later to re-examine the extent to which the Government should use the powers available in regard to safe construction and operation under the 1948 Act.

Mr. Butler also answered a number of questions regarding the export of nuclear energy plant and equipment. Discussions proceeding for some time between the Atomic Energy Authority and representatives of the heavy electrical plant manufacturers on the possibilities of export trade in nuclear power reactors are being widened, and considerable publicity is being given to the United Kingdom's achievements and potentialities. The United Kingdom has already established a substantial export trade in isotopes and new types of instruments for use in industry and research; but the commercial development of nuclear power is still in its infancy, and a substantial demand for, or export

of, power reactors is unlikely for some years. Long-term plans in this field are already being considered by the Lord President and the Atomic Energy Authority with the President of the Board of Trade. Mr. Butler agreed that the proposals made by the working party of the Organization for European Economic Co-operation for the nuclear energy industry would offer an admirable outlet for the industry of Britain but declined to enlarge on the subject.

It may be recalled that on February 28, in welcoming President Eisenhower's imaginative offer to supply uranium for the development of the peaceful uses of nuclear energy, the Prime Minister referred to developments under the Colombo Plan and Bagdad Pact, as well as in bilateral arrangements between the United States and Great Britain and certain countries in Africa and Asia to help them in training in the peaceful uses of nuclear energy. On March 21, Mr. Butler again emphasized the disability of Britain, compared with the United States, in regard to supplies of enriched uranium; but he undertook to consider further the allocation of such supplies between defence and civil needs and the possibility of obtaining supplies from the United States. Again, in the debate on the international situation in the House of Lords on March 27, Lord Layton pleaded for strong support by Great Britain of the proposals made by the Organization for European Economic Co-operation for the co-operative control of the development of nuclear energy, urging that it is all-important that we should be associated at the start with the development for peaceful purposes of nuclear energy.

Lord Reading, in replying for the Government, claimed that the Government is at present considering how far the Euratom proposals and those of the Organization for European Economic Co-operation can usefully be dovetailed one into the other, and that it is not at all indifferent towards the idea of assisting the various European organizations which exist. Nevertheless, it may be doubted whether, even from the point of view of Britain's own interests, the Government has been sufficiently imaginative as regards the proposals for European co-operation in this field. A central organization strong enough to control the uses of nuclear fuel, to promote the joint construction of nuclear power plants and to negotiate with the United States on the offer of uranium would have advantages also in the administration of technical aid from Europe to the undeveloped countries of Asia and Africa. Particularly in the Middle East, it might offer some prospect of abating the political tension which too often has attended the giving, or even the offer, of assistance by individual countries.

But the questions and statements in Parliament regarding the development of nuclear energy for industrial purposes have scarcely so far touched on the vital issues. The important question, now that a beginning has been made with such applications in industry, is not so much whether the conditions of co-operation between the Atomic Energy Authority and private industry ensure the Government the necessary control, or even that industry pays a reasonable price for the information and technique placed at its disposal. There is little reason to fear that the national interest will suffer in either of those respects. What is much less certain is that the conditions of co-operation are such as to encourage the initiative and enterprise and the taking of risks that are inseparable from new ventures.

While British firms are at last being allowed to participate in the design of nuclear power stations, in research into nuclear power plants for aircraft engines, in the development of an atomic submarine for the Royal Navy, and in the development of nuclear power for shipping, and one is being supplied with fuel for the research reactor which it is to build for itself, it must be remembered that there are only a few enterprises in Britain that have the technical and financial resources to take up nuclear engineering. There has indeed been a further relaxation of the old secrecy about the technical processes in Britain's nuclear factories, and the British Government is prepared to supply natural uranium for any power station which a British firm may sell abroad.

None the less, it will take all the technical skill and enterprise which Britain's scientists and engineers can produce to offset the advantage which the United States possesses in being able to offer much more abundant supplies of the enriched uranium for the same purpose; so long as restrictions inevitably imposed by bilateral agreements between users of uranium and the British or American Governments remain, the nuclear energy authorities will be the final arbiters of the speed of progress, and doubts will persist as to whether the possibilities are being explored with all the imagination and enterprise that are available. One advantage of associating private industry with a public authority is that the former can take risks that no public body can afford to do with public money.

But industry cannot be kept indefinitely in leading strings and subject to monopoly rights over the whole field of nuclear energy which the Atomic Energy Authority has hitherto possessed. Even now it is doubtful whether the nuclear physicists and engineers in Britain as a whole possess the experience to judge whether the programme set forth a year ago in the White Paper is still sound, or whether a further experimental programme even on the design of nuclear power plant is desirable. Until, however, such questions can be discussed realistically and responsibly in the scientific and technical Press, it is impossible to judge whether the efforts of the thousand scientists and technologists which Sir John Cockcroft estimates are working on nuclear power development in Britain are wisely directed, and how sound in relation to available resources is the annual expenditure of £200 million on nuclear power stations contemplated from 1965 onwards.

It would not be reasonable to suggest that the Atomic Energy Authority is averse to experiment outside its own establishments; but it is understandable that it may be somewhat prejudiced in its judgment. Nor, even with the strongest motives for encouraging development in industry, rather than in

its own establishments, can it be assumed that the Authority is necessarily the best judge of the worth of an experiment. It is altogether in the nation's interest that industry should be encouraged to engage in longer-range experiments, while the Authority is preoccupied with the immediate development of nuclear power stations; and if some relaxation of the Authority's right to acquire the patent of any invention which it judged relevant to the development of nuclear energy would stimulate such enterprise, the relaxation would be well worth while. What matters above all in such a field is imagination and enterprise, and methods of control or forms of organization which repress initiative and discourage experiment and the taking of risks, either by the industrial firms or at the international level, so far from ensuring security endanger the whole economic future of Britain.

It should not, therefore, be taken for granted that the Authority's present ideas of its partnership with industry should govern that partnership indefinitely. Industry may be content to rent fuel from the Authority in the first instance; but if industry's first designs work, it may reasonably expect permission to fabricate the actual elements itself from billets of uranium supplied on a rental basis. Nor would it be unreasonable for industry to hope in due course to take a larger part in applied nuclear research, and to be admitted to real partnership with the Authority on common research projects. Such developments could not fail to be in the national interest; and although they are not immediate issues, it is not too early to be giving thought to such differences of interpretation of the "close partnership" and their reconciliation, as well as to the relative scale of the total effort which Britain can afford to make in the development of nuclear energy. The secrecy problems now arising in development work out of the association of the Authority with different industrial interests should be handled from the start with sufficient forethought to avoid prejudicing future relations of the Authority with industry in general. The draft statute for an international atomic agency, approved in April in Washington by a group of nations, should stir the British Government and the Atomic Energy Authority to think ahead and approach problems of secrecy, security control and industrial partnership with vision and energy.

BIOLOGY OF PUBERTY

Growth at Adolescence

By Dr. J. M. Tanner. Pp. xii+212. (Oxford: Blackwell Scientific Publications, 1955.) 32*s.* 6*d.*

HUMAN growth and maturation have been explored during recent years with immense enthusiasm, particularly in the United States. On the descriptive plane much information has been accumulated from anthropometric, photographic and radiological observation. Some physiological and endocrinological facts have also been gleaned, and much has been written on the psychology of adolescence. What biological insight has been obtained into the processes which overtake the human body at puberty? In this succinct monograph Dr. J. M. Tanner provides an appraisal which displays the real achievements as well as the considerable deficiencies in our present knowledge. The achievements rest mainly on the more exact description of the 'external' events of pubescence, the changes in dimensions of the body and its segments, the relative growth of different tissues, the individual variability of response and the developmental contrast of male and female. The deficiencies affect particularly our understanding of how the sequence, synchrony and changing tempo of events are regulated, and what is happening to the brain and endocrine system.

The merit of Dr. Tanner's presentation is that he conducts the reader with directness to the essentials. At the outset he insists on the use of 'velocity' rather than the usual 'distance' curves of growth to display the sharpness and timing of the adolescent 'spurt'; and he explains also that many of the shortcomings of the data arise from failure to follow the same children consecutively. The adolescent spurt is shown to be a general event affecting the facial, cranial and body skeleton, in a particular sequence, as well as viscera, musculature and other tissues. Coupling these morphological changes with events in the reproductive system leads him to a consideration of the concept of bodily maturity and of its assessment. The main conclusions here are the existence of a "tendency for a child to be advanced or retarded as a whole; in the percentage attained of his eventual size, in his skeletal ossification, in his permanent dentition, doubtless in his physiological reactions, and also in his intelligence test score" (p. 62), and the inadequacy of chronological age to reflect the physiological status of the individual.

Of the factors determining or modifying growth at adolescence, very little can at present be said of the genetic basis or of the influence of race or climate; rather more is known of nutritional effects, where it seems likely that "the time of occurrence of the adolescent spurt is a more sensitive indicator of nutritional deficiency than is the growth rate at earlier periods" (p. 85); there are definite socio-economic differences in growth for which various explanations are considered (though the significance of differential fertility is not); information on the effect of illness appears to be very limited (but Harris's bone lines are not mentioned). Substantial evidence is adduced for the belief that the onset of adolescence has been speeding up in many countries during the past fifty years or more. Whether the adult body size has also increased with this accelerated maturity is said to be a matter of dispute (p. 86), although no data are given opposing the affirmation (p. 92) that the "ultimately reached adult size is greater".

The possibilities of predicting size and physique or attainment of maturity from chronological or developmental age have naturally engaged much attention. Such predictions are complicated by the influence which the time of onset of the adolescent spurt exerts on the developing physique. Nevertheless, the extent to which the pre-adolescent physique can be remoulded by this factor is stated to be relatively small, and no 'radical' change in body build ensues. This conclusion is important enough to deserve a more detailed demonstration, as is the claim "that there is little doubt that someone used to looking at

children's photographs could predict with accuracy the adult somatotype from a picture taken at age 5 or even earlier" (p. 78).

Of the complex and interrelated endocrinological happenings at adolescence Dr. Tanner shows how limited and careful interpretation must remain at present. When it comes to tracing the changes in mental ability at puberty and their relation to neural events, the information peters out.

This book will certainly be of service to a wide circle of students of human biology and medicine. It provides also the basis for an attractive and highly instructive pre-clinical course for medical students.

J. S. WEINER

CHEMICAL TECHNOLOGY

Encyclopedia of Chemical Technology

Edited by Raymond E. Kirk and Donald F. Othmer. Vol. 11: Polyols to Rutin; pp. xvi+950. Vol. 12: Sabadine to Stilbestrol; pp. xvi+955. Vol. 13: Stilbite to Thermochemistry; pp. xvi+952. Vol. 14: Thermodynamics to Waterproofing; pp. xvi+980. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1953–55.) 30 dollars each volume.

THESE further four volumes of Kirk and Othmer's "Encyclopedia of Chemical Technology" deal with subjects from polypropylene to water. Vols. 1–10 have already been reviewed in these columns (*Nature*, 164, 935 (1949), and 173, 228 (1954)). The "Encyclopedia" is designed to provide, from an industrial point of view, a summary of knowledge of materials, methods, processes and equipment for the chemist and the chemical engineer. It contains authoritative articles, arranged alphabetically, by experts from the chemical industry and research institutions in the United States. Thus it is an American production. It provides a vigorous, clear, informative and up-to-date picture of chemical technology as practised in the United States. It will be valuable, and even indispensable, in chemical laboratories and industrial libraries; it would indeed be useful to individual men of affairs to provide them with information about other subjects not immediately in their purview. It is useful also to the teacher of chemistry and chemical engineering and to the student, for the articles relating to the scientific basis of technology seem to be presented in a way which includes the essentials without overloading them with unnecessary details. Furthermore, the lay-out of the articles, the arrangement and the printing are very satisfactory and the diagrams are well chosen and highly informative.

The subjects dealt with in these four volumes include articles on the main branches of chemical industry, among which may be cited, for example, printing, pulp, pyrotechnics, rayon, refrigeration, rubber, salt, silicones, soap, solvents, steel, sugar, sulphuric acid, tanning, tea, textile technology, tobacco, varnishes, industrial wastes and water. There are also valuable articles on techniques: for example, powder metallurgy, pressure measurement, technique for high pressures, radiography, sampling, size measurements of particles, staining, temperature measurement, ultrasonics, vacuum technique, and viscometry (volume measurement is cross-referenced to fluid mechanics in an earlier volume). Another class of article is that relating to particular processes, such as power generation, quality control, safety precautions, sedimentation, silvering, size separation, spraying, etc.

Then there are articles dealing with the properties, production, and use of individual chemical substances or classes of substances. Many of these articles, like those relating to silica and inorganic silicates, are highly informative. It is useful to have recent information such as is provided by the articles on titanium, tantalum, the terpenes, the vat dyes, etc. There are a number of articles relating to pharmaceutical products, and substances of therapeutic value such as streptomyces antibiotics, stimulants and depressants, sulphur drugs, thyroids and antithyroid preparations, vaccines, vitamins, etc.

Besides all this, there are a number of satisfactory articles on the physical-chemical basis of chemical technology: radicals, radiochemistry, Raman effect, reaction kinetics, stereochemistry (organic and inorganic), thermochemistry, thermodynamics, valence, vapour-liquid equilibria, etc.

Separated in this way, some indication is given of the contents of these present volumes under review. There are other articles which lie outside such a classification: for example, those on trade marks and smokes and fumes. The latter article includes a table of the threshold or maximum concentrations, for continuous eight-hour exposure with no impairment of health, of various gases and vapours present in industrial atmospheres, together with the dangerous and fatal concentrations. It also provides tables of collector equipment for solid and liquid aerosols, their efficiency and the estimate of costs. Much attention has been paid to atmospheric pollution by industry in the United States during recent years, and such an article summarizing some of the results of inquiry is particularly useful.

There are other articles which also lie rather outside the strictly scientific field; those, for example, on materials such as salad dressings, shampoos, tints, hair dyes and bleaches. These take up about fifty pages of these four volumes of 950 pages each; whether that is in proportion to the magnitude of these frills of civilization to that of the total chemical industrial trade of the United States has not been ascertained.

One can open the books at random and almost at any place find points of interest—a very good test of such books. For example, opening at p. 929 of Vol. 13, the reader finds a note on thallium oxide: "which begins to sublime at 300° C. in high vacuum although its boiling point is at least 1,080° C. . . . at higher temperatures some peroxide is formed". These are interesting facts, which accord with the reviewer's experience. Higher up the page, "the addition of 0·5 to 5 per cent Thallium to gold or silver for electrical contacts is claimed to reduce the tendency of these to stick"; that might be a useful tip.

The thirty-four page article on thermodynamics is particularly clear. It uses the nomenclature recommended by the American Institute of Chemical Engineers, which differs from the international one only in that A is used instead of F for the total work function.

Most of the articles are informative and satisfying: the expert in any particular field or the person who needs to follow up a subject could no doubt pick some holes, or be disappointed that there is not more detail. The merit of an encyclopædia, however, depends very much on striking the right balance between scrappiness and prolixity, and these volumes seem generally to contain well-balanced articles.

The survey article on the sugars perhaps omits too much, and that on the proteins seems to include very little of the results of interesting recent attacks on their structure by X-ray methods.

Some articles in some of their aspects and in relation to the quotation of bibliographical references are apt perhaps rather to overstress recent work in the United States and to understate the scientific development of the subjects as resulting from a world-wide effort. This is a tendency in every country, particularly in regard to technological subjects rather than to fundamental scientific subjects, and it should be avoided so far as possible.

This fifteen-volume work as a whole (there is one volume yet to come) is beautifully produced. Although it is costly, it is a worthy publication of a great industrial nation, and most technical libraries will need to keep it readily available.

A. C. Egerton

SKYHOOKS AND SATELLITES

200 Miles Up

The Conquest of the Upper Air. By J. Gordon Vaeth. Second edition. Pp. xiii+261. (New York: The Ronald Press Company, 1955.) 5 dollars.

THE approaching International Geophysical Year of 1957–58, with the incidental project of an artificial satellite, has stimulated the second edition of this book, which first appeared in 1951. As head of the New Weapons and Systems Division in the United States Office of Naval Research, Mr. Vaeth speaks authoritatively, and it is good to read an account of upper-air research which, intended primarily for the general reader, is so completely scientific in its outlook. People naturally want to know also how far at the present time the fantastically improbable has developed towards the fantastically possible, and there is a little speculative spacemanship at the end. But this is not confused with actual achievements or projects seriously in hand, and the great value of the book is in its emphasis on the real objects of high-altitude exploration.

The reader will probably turn first to Chapter 12, which outlines the possible construction, and the problems of launching, instrumenting, and tracking the Minimum Orbital Unmanned Satellite of the Earth (entitled MOUSE) suggested by Dr. S. F. Singer. Circulating at a height of about two hundred miles, in a track passing over two stations near the poles, this would release stored information to the stations every half-revolution. (One can forecast that the whimsical trend of scientific jargon will find an appropriate name for the reception of these observations, such as 'taking the Mickey'.) Trial runs may first be made with uninstrumented projectiles. Launching will most likely be from ships at sea—not, as in the almost prophetic diagram in the "Principia", from a mountain-top. The life of such a satellite is expected to be a day or two.

The earlier chapters give an excellent account of the physics of the atmosphere, the information sought, the various instruments used, and the telemetering equipment for transmitting results from rockets and balloons. Pictures of the complete laboratories and radio stations fitted in modern rockets give a good idea of the complicated tasks each fulfils in its short mission. The activities at the White Sands Proving Ground are described at first hand, and the development from the early captured *V2* to the W.A.C. Corporal is explained with a good deal of technical detail. The progress of the modern balloon, culminating in the gigantic Skyhook cells, which may be as large as three million cubic feet, is fully dealt with. To the rocket-minded, this revival of interest in large balloons may seem like an echo of the 1930 period. But the firing of a rocket is an event, and the recovery of the remains an enterprise, while unmanned balloons carry the routine traffic of the upper air, and are very much less costly. Indeed, Mr. Vaeth says that it is probable that the first steps towards a closer acquaintance with Mars will be made in the summer of 1956 from a manned balloon observatory, carrying a 6-in. telescope and spectrographic equipment above the disturbances of the earth's atmosphere. Little information is available about this, except that the craft will be called Explorer III, as a successor to the balloons manned under the late A. W. Stevens. Incidentally, Skyhook balloons, travelling rapidly in high-altitude winds, have been shown to account for many 'flying saucer' observations; indeed, as the photographs of them show, they look like nothing else. But the author records one unidentifiable object that was definitely not a balloon, and refuses to be drawn into controversy.

Admirable photographs, a readable style, and an objective approach make this a book which will be received both with enjoyment and with confidence.

G. R. Noakes

DIELECTRIC CONSTANT AND LOSS

Dielectric Behaviour and Structure

Dielectric Constant and Loss, Dipole Moment and Molecular Structure. By Prof. Charles Phelps Smyth. (International Chemical Series.) Pp. x+441. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 64*s*. 6*d*.

DURING the past ten or fifteen years, measurements of the dispersion of dielectric constant have been characterized by a new and altogether higher level of precision. This has been achieved partly by the development of microwave methods and partly by experimentation at low temperature when the dispersion is shifted into the radio- and audio-frequency region. The use of microwaves has the unique advantage that the investigation of electrolyte solutions has become practicable. Prof. C. P. Smyth's book is a timely summary of the knowledge and attitudes that are the result of these advances. The subject is treated in two parts. The first, a discussion of the dielectrical properties of matter, occupies rather more than half the book; the second part is devoted to a survey of dipole moments as a tool in the study of molecular structure. Comparison with the author's previous book published twenty-five years ago shows how great has been the expansion of the subject in the intervening time.

In fundamental theory the developments represent a consolidation rather than an advance to new positions, and it is perhaps of interest to glance at the current picture of the mechanism of dipole reorientation. Hindered rotation, introduced as a

macroscopic concept twenty years ago by Debye and Fowler, emerges with a new look. The Lorentz field employed by Debye has tacitly been dropped in favour of the Onsager field, and the Onsager equation is accepted as a reasonable approximation for non-associated polar liquids. Analysis of dipole reorientation as a kinetic process has led to the evaluation of thermodynamic parameters which have illuminated the molecular interpretation of dielectric relaxation. It is agreed that a molecule usually rotates as a unit, the rotation of a prolate molecule about its long axis being demonstrably the easiest, although there are isolated examples of very large molecules wherein reorientation occurs by intramolecular torsion. The hindering effect of adjacent dipoles is emphasized by the observation that the energy barrier opposing reorientation is greater for a pure polar liquid than for a solution in a non-polar medium of the same viscosity. Associated liquids remain a difficult problem in spite of the early success of the Kirkwood equation relating the dielectric constant of water to its dipole moment. In this treatment the reorienting unit is a single molecule, an assumption powerfully supported by the fact that the dielectric loss in the principal dispersion region—rather surprisingly for a quasi-crystalline liquid—is compatible with a single relaxation time. Earlier theories which explained the high dielectric constant of associated liquids by the rotation of molecular aggregates (the simplest expression of co-operative effects) are therefore suspect, at least in their simplest form. In solids, transitions signalize the onset of molecular rotation which often is relatively free in crystals of high symmetry. The mechanism of dipole reorientation in ice is still unsettled, but there is now definite physical evidence in favour of a process involving non-classical proton transfer in certain solid alcohols.

Prof. Smyth writes for the chemist rather than the physicist or electrical engineer. In deriving the basic equations—not always rigorously—he is at pains to describe the physical background, a point which will commend itself to non-mathematical readers. A careful balance is maintained in areas of controversy, and his book is recommended to the honours student, general reader and specialist alike.

J. C. D. Brand

MICROSCOPY OF VEGETABLE FOODSTUFFS

Mikroskopische Untersuchung pflanzlicher Nahrungs- und Genussmittel

Von Dr. Gustav Gassner. Herausgegeben von Dr. Friedrich Bothe. Dritte, verbesserte Auflage. Pp. xvi+400. (Stuttgart: Gustav Fischer Verlag, 1955.) 33 D. marks.

ALTHOUGH the late Prof. Gustav Gassner's book on the microscopy of foodstuffs of vegetable origin, which was first published in 1931, has now reached its third edition, the reviewer has only recently had an opportunity of studying it for the first time. The author having died while the preparation of the third edition was still in progress, the work has been completed by Dr. F. Bothe. It must at once be emphasized that this book deserves to be much more widely known and used in Great Britain than it appears to be at present, and it is a work of reference that merits a place on the shelves of all public analysts, economic botanists and microscopists who are concerned with maintaining the standard of purity of foodstuffs, and detecting adulterants in them.

As its title implies, the subject-matter of the book is essentially the microscopical structure of the products described in it, and it includes but little information concerning their sources and uses, although these are briefly mentioned.

The book is divided into thirteen chapters, twelve of which deal with such topics as cereals, starches, vegetables, condiments, beverages, spices, and seeds and fruits that are valued because of their content of oil. To give a few specific examples, the reader will here find particulars of the microscopical structure of a wide range of peas and beans, of arrowroot and sago, of dill and vanilla, of such diverse fruits as apples and dates, of cocoa and coffee, not to mention such homely vegetables as spinach and parsnips. There is a special chapter devoted to the microscopy of honey, and another on fungi includes details of morels and truffles and even of the *Penicillium* that is used for flavouring Roquefort cheese. The remaining chapter includes simple, effective, practical directions for examining foodstuffs under the microscope. The book ends with a good subject-index; but there is no bibliography.

The 866 line drawings by which the book is illustrated constitute one of its most useful features, and what a pleasure it is to find that all of them are original, well drawn, and show very clearly those characters that have proved to be the most valuable for diagnostic purposes. The illustrations are at a few selected magnifications, which have been used as standards throughout the book, so that the reader can at once form a mental picture of the relative sizes of the tissues and cells, as well as of the bodies enclosed in them, such as starch grains or crystals.

Although much of the information in the book is already available from other sources, it is an advantage to have clear and simple descriptions of the salient diagnostic characters of such a wide range of materials brought together within the compass of a book of no more than four hundred pages. The microscopical descriptions are so easy to understand that they could have been written only by a botanist with an intimate first-hand knowledge of his subject. Indeed, the whole book is manifestly based on the practical experience of the author and his colleagues.

Since the subject-matter is arranged according to the uses of the various items, rather than on a botanical basis, it follows that products derived from closely related botanical species are not always described in the same part of the book. Thus, for example, seeds derived from species of *Brassica* are described partly under oil seeds and partly under spices. This, however, is no serious disadvantage provided the reader realizes the position.

The reviewer is interested to note that many of the substitutes and adulterants described in this book are precisely the same as those which he has encountered in the course of his own work. It is indeed fortunate for microscopists whose business it is to ensure that a high standard of purity is maintained in economic plant products, that those bent on adulteration and substitution are so conservative in the selection of the materials they employ for these purposes.

C. R. Metcalfe

Gas Kinetics

An Introduction to the Kinetics of Homogeneous Gas Reactions. By A. F. Trotman-Dickenson. Pp. x+322. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1955.) 40*s*.

A NEW account of chemical kinetics by an active worker in the field is generally welcome, and the present volume is no exception to this. In his preface the author states that the book is written chiefly for undergraduates and for those beginning research. Almost inevitably the author's background and his desire for completeness render the treatment over-elaborate for the student and more suitable for the research worker, for whom the copious bibliography should be useful. Certain sections, such as that on transfer reactions, concern relatively new, expanding topics which would enhance an undergraduate course and which are almost unavailable at 'text-book' level. The book deals largely with the author's interests and, although this leads to a certain bias, it has the advantage that much recent work is collected together for the first time, and the writing shows considerable freshness of approach.

Certain diagrams and tables are difficult to follow, partly because there is a tendency to include excessive detail; and in some respects the text falls between two ideals. For example, in discussing Slater's theory, the reviewer feels that either a brief outline of the theory followed by its results should be given, or sufficient detail to enable the reader to work through an example for himself.

The general level of clarity of definition and readability is good, but occasionally, as in the all-important first sentence of the introduction, the style is obscure. The book is stimulating, good value and it deserves to be read. K. E. Howlett

Transistor Audio Amplifiers

By Richard F. Shea. Pp. xiii+219. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 52*s*. net.

JUNCTION transistors are rapidly replacing thermionic valves for audio-frequency amplification in many applications. Many circuit engineers with a particular interest in this topic will therefore be interested in this new book by R. F. Shea, which deals exclusively with it.

The book contains a mixture of theoretical and practical information. In common with most publications on transistors, it hinges on the use of 'equivalent networks'; one reason for this is that the internal feedback that occurs in transistors makes any other method of calculating their performance very difficult. It is a pity, however, that the author has not said more about the why and how of these networks before using them.

Almost a quarter of the book is devoted to listing manufacturers' data on a large number of American transistors. Scarcely any use is made of this material, which is, in any event, of little value in a book aimed at teaching fundamentals.

The book deals with the theory of the basic amplifier arrangements. It also has a chapter on pre-amplifiers where low noise and a reasonably high input resistance are required. Power amplifiers are discussed in some detail; in the case of class *B* circuits particularly, little is said about the relative merits of the various arrangements or how they can best be driven. Finally, there is a useful chapter on the design of four practical amplifiers.

This book will probably find a place on the library shelves at establishments interested in transistor circuits. Some engineers may find it of sufficient value on some topics to acquire their own copies.

D. D. Jones

An Introduction to Interferometry

By Prof. S. Tolansky. Pp. viii+223+5 plates. (London: Longmans, Green and Co., Ltd., 1955.) 21*s*. net.

THIS book on interferometry sets an example that might well be followed in other branches of physics, for it is not often that an acknowledged authority sees fit to write a text-book on his own subject for ordinary-degree students. It is refreshing to read a work at this level written by an expert teacher who is, at the same time, completely familiar with the practical details of the experiments and instruments he describes.

The subject-matter is necessarily far more than could normally be included in a degree course, but those who have to teach physical optics will find the book a source of inspiration for the particular sections of interferometry with which they may wish to deal. A great variety of interferometers is included, with emphasis on practical detail and the particular uses to which they are put in practice. The theory is elementary, and no elaborate mathematics is used.

The excellence of the book is somewhat marred by evidence of careless and hurried writing. Some of the earlier diagrams are poor (for example, in Figs. 2.11 and 5.7 rays are shown passing through lenses without deviation, and in Fig. 4.6 reflected rays do not obey the law of reflexion); punctuation is sometimes incorrect, and there is constant use of the adverbs 'thus' and 'hence' as conjunctions. I hope that there will soon be a second edition in which all the diagrams and the text match the very high standard of the contents. H. Lipson

The Mechanism of Evolution

By W. H. Dowdeswell. (The Scholarship Series in Biology.) Pp. ix+99. (London: William Heinemann, Ltd., 1955.) 6*s*.

THE concept of evolution has revolutionized biological thought during the past century, yet its full significance tends to be missed in school science courses, leaving a prevailing impression of something vast and rather unreal, which took place in the remote past. Mr. Dowdeswell's remedy is to incorporate with the classical evidence an understanding of the ways in which small evolutionary changes going on now, in wild populations around us, can be studied experimentally. The fact that many such experiments could be undertaken by the schools themselves makes it all the more stimulating.

After a preliminary survey of the historical background, variation is described in the light of modern genetics. There follows a discussion of natural selection and the effects of such factors as population size, continuity or isolation upon it. Examples drawn from many fields, including the author's own researches, lend intense vitality to the account. In conclusion, practical advice is given on experimental studies, and there is a summary of the present status of evolutionary theory, followed by a glossary and bibliography.

The book should prove immensely useful not only to the sixth-form boys and girls for whom it is intended, but also to teachers and first-year university students. Maurice Ashby

COLLOIDS AND THEIR BEHAVIOUR*

By Sir ERIC RIDEAL, F.R.S.

SINCE Graham's time there have been several attempts to define in a sufficiently embracing manner what is generally designated the colloidal state of matter. While the majority of workers in this field agree that form is an important factor, there is little doubt that Bancroft went too far in relying on this as the sole criterion, and McBain was too inclined towards a vitalistic view. The recognition that there exists between any two phases a third or interphase—the forgotten dimension of W. Ostwald—and that the properties and reactivity of matter constituting that phase or, as Sir William Hardy termed it, matter in the boundary state, differed from that in either of the bulk phases embracing it, leads us to attribute 'colloidal' properties to such manifestations, the *Kapillarchemie* of Freundlich. The greater the influence of matter in the boundary state on the system as a whole, the more manifest will be its colloidal properties. Evidently the two bulk phases must be so disposed relative to one another that interphase may constitute an appreciable fraction of the whole, and it is this interdispersion which is revealed in such a wealth of variety of forms.

Of fundamental importance in our approach to colloid science are the properties of liquid and solid surfaces.

Liquid–vapour and liquid–liquid interface are surfaces of equipotential and their free and total surface energies are readily measurable; in consequence, both the thermodynamic treatment and experimental investigations into the surface properties of capillary-active solutions and the behaviour of monolayers is well advanced. These investigations have added strength to the assumption that molecules at interfaces are orientated, and the unique properties of matter in the boundary state are in great measure due to this asymmetrical disposition. Detailed examination of monolayers both by means of surface pressure and surface potential measurements has presented us with examples in two dimensions of all the three well-known bulk states of aggregation, solid, liquid and gaseous, and as we might anticipate from the fact that orientation is one of the important features, we find in addition a large variety of orientated liquid or nematic states. The extension of the interphase in the bulk phases in these systems results in the formation of mists, foams and emulsions. In the former, the formation and growth of nuclei consisting of clusters of molecules, which in turn may either disintegrate again or re-arrange themselves to a more stable configuration and then proceed to grow by condensation of molecules taking place at a greater rate than evaporation, is a sequence of processes which, thanks to the investigations of Frenkel and Becker and Döring, have been capable of being analysed, while the experimental investigations on light scattering commenced by Tyndall in the Royal Institution has, as is well known, led to a wealth of information in such varied fields as coagulation at the hands of Whytlaw-Gray and La Mer and size and shape distribution by Debye.

We note that the growth of mists can take place either by further condensation of vapour or by coagulation of mist particles already formed. Our knowledge concerning the stability of emulsions is, in spite of their importance, still very incomplete. It is clear that since the interfacial free energy at the boundary of immiscible liquids is relatively great, two-component emulsions must be relatively unstable, and the first requisite of an emulsifying agent is to lower the interfacial surface tension. The distortion of a spherical drop leads to an increase in area, and in order to maintain a low interfacial tension more emulsifying agent must flow into the interface from one of the bulk-phase reservoirs. Further, if the emulsifying agent is present at the interface as a compressible two-dimensional liquid possessing a bulk-surface viscosity rather than as a vapour, a mechanical as well as a surface-tension brake is put on the extent of distortion of the sphere, and the stability of the emulsion is enhanced.

A simple picture of the process of curving an originally plane interface shows that the magnitude of the partition coefficient of the emulsifying agent between the two bulk phases serves as a criterion as to whether an oil-in-water or water-in-oil emulsion can be formed and where the inversion point is to be found. Attention may be directed to the possible significance of the inversion point in living systems. Among the more important factors contributing to the stability of colloidal suspensions are the electric charge and the extent of interaction of the colloid with its dispersion medium, that is, solvation.

Electric charges on colloid dispersions may come into existence through either surface ionization or through selective adsorption of ions from the medium. Pauli was a protagonist of the first view, regarding colloid particles as large ions, and his school has presented us with a wealth of analytical data in support of it. We can divide the distribution of the ions near the surface into two regions: those at or near the surface, confined in what is termed the Helmholtz or Stern double layer, and the diffuse or Gouy atmosphere, respectively. It is the latter that is responsible for electrokinetic phenomena. On adding electrolyte, the thickness of the diffuse layer decreases, the surface ionization is reduced and the adsorption of counter ions increased until coagulation and eventual precipitation ensue. The kinetics of this process have been examined and the results shown to be compatible with those anticipated from the effects of Brownian movement. By some, the ions held in the diffuse layer are regarded as being held by the type of restraint postulated by Donnan. On this view, the effective equivalent concentrations of multivalent ions would stand in the sequence M, $\sqrt[2]{M^{\cdot\cdot}}$, $\sqrt[3]{M^{\cdot\cdot\cdot}}$, an order given by the ordinary lyotropic series; but that physical or dispersive forces play an important part in such adsorption is clear from a consideration of the effectiveness with which wool can be dyed with the anions of many organic acids, or as seen in the following series of salts required to coagulate an arsenious sulphide sol:

* Substance of a course of three lectures for school teachers delivered at the Royal Institution on February 28, March 6 and 13.

Salt in millimoles/litre

Sodium chloride	51	Morphine hydrochloride	0·425
Guanidine hydrochloride	16·4	Neofuchsine hydrochloride	0·114

Ionic exchange at the surface of ionogenic colloids may result in the precipitated colloid containing more of the precipitating ion than is necessary for neutralization of the electric charge.

The results of adding electrolytes to the hydrous oxides in the sol or dispersed form are more complicated, for these colloids represent a transition between the hydrophobic and the hydrophilic systems. A sol of sufficient concentration of, say, ferric hydroxide undergoes gelation on addition of a small quantity of electrolyte. The sol particles must be regarded as networks of ferric hydroxide, containing, if made by hydrolysis of the chloride, a certain number of chloride ions with positive charges on the network. On reducing the charge, portions of the network are without charge and can adhere to one another. A very open structure is thus built up, containing both water of hydration and water within the network.

The network maintains a distended form partly owing to the residual charge and partly owing to the osmotic pressure maintained by the Donnan distribution. These gels, slowly and more rapidly, in the presence of large quantities of electrolyte, may become more and more compact and indeed may gradually lose their water of solvation as the network links join up by chemical interaction. Ferric hydroxide may be converted into goethite, Fe(OH)O. The conversion is also naturally accelerated by warming. During this process of contraction the residual aqueous phase separates, a phenomenon termed syneresis.

If, first, sufficient electrolyte be added to cause the sol to gelatinize, this rigid network may be broken up by agitation; and on allowing it to stand, those portions of the fibrils which are not charged may in virtue of their Brownian agitation recohere to form a rigid gel again. This is a thixotropic system and is well exemplified in, say, a 0·5 per cent suspension of the well-known clay bentonite. We note, on the progressive addition of an electrolyte, first the cessation of lateral Brownian agitation, then of rotational motion. At this stage the system is still thixotropic. Further addition of electrolyte produces aggregation and then true coagulation. Important examples of thixotropic systems are found in Nature, for example, protoplasm. If we examine the still more solvated systems such as the proteins, starches, agar agar in water and many polymers in non-aqueous systems, these do not flocculate when brought to the isoelectric point but may be caused to gel, in which form they are quite stable. But large quantities of salt are required to precipitate them. The contrast between the salt sensitivity of the suspensoids and the solvated colloids is made use of in the determination of the gold number. For many proteins small quantities of salt are required to render them soluble.

The stability of these highly hydrated colloids may be reduced by methods other than salting out. Thus we may dehydrate the solvated groups by addition, say, of alcohol, when the viscosity rapidly decreases and the sol becomes optically opaque and sensitive to flocculation by electrolytes (Fig. 1). We also find that there are substances which render the dispersion still more stable to electrolytes and counteract the sensitization produced by alcohols. These are

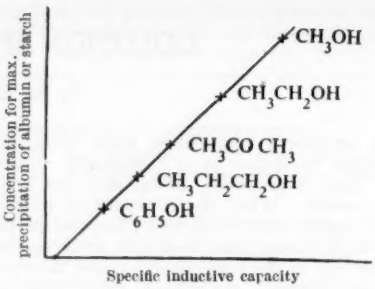

Fig. 1

peptizing agents and include such substances as acetamide, urea or sodium thiobarbiturate.

We can imagine with Katz that these substances are adsorbed by the colloid by covalent linking and alter the relative number of the polar and hydrated groups; thus

$$\bigcirc = S = C \begin{matrix} NH_2 \\ NH_2 \end{matrix}$$

introduces two new polar groups on adsorption and is consequently a peptizing agent; but

$$\bigcirc = S = C \begin{matrix} N(C_2H_5)_2 \\ N(C_2H_5)_2 \end{matrix}$$

or, say, tannic acid, renders the sol more hydrophobic and is thus a sensitizing agent. Just as the more hydrophobic metallic hydroxides can acquire a thixotropic state by careful adjustment of the extent of charge and solvation, so these more solvated systems, on sensitization by, for example, alcohols, can link up and form a separate but highly solvated phase, the so-called coacervates. These can also be formed by mixing two oppositely charged hydrophilic colloids together, for example, gelatine and gum arabic at a *p*H less than 4·8, when the gelatine is positively charged and the gum arabic negative. It is possible that the carefully balanced system sol $\rightleftharpoons$ coacervate $\rightleftharpoons$ gel plays an important part in the phenomenon of narcosis, a view long held by Claude Bérnard.

We have seen that the gel structure is produced by the interlocking of the solvated fibrils. It is pertinent to inquire how a solvent reacts with a dispersible solid, for example, a solid polymer. In general, these are partly crystalline and partly amorphous. The ratio of crystalline to amorphous phase is revealed by X-rays or by density determinations, varying greatly with the nature of the polymer and the state of tension and extension. We regard the fibrils as constituting both the amorphous as well as when adlineated the crystalline portion, the consequent structure being termed a fringed micelle.

In the amorphous portion the specific heat is greater than in the crystallite and possesses more entropy since the fibrils here can move. On addition of a solvent, the free spaces in the amorphous portion are filled, the movement of the fibrils is restricted and the entropy decreases; thus the preliminary wetting should be accompanied by a heat change. On adding more solvent, the swollen fibrils distend further and the crystallites commence to be pulled

apart. At this stage the fibrils acquire more movement, the entropy increases and the process of imbibition goes on until, if the polymer be cross-linked, a steady and permanent extension is obtained. The conditions for equilibrium in such swelling are given by the thermodynamic relation :

$$\Delta H = \Delta F - TAS$$

Since $\Delta F = 0$ at equilibrium, $\Delta H = -TAS$. The heat of mixing of two liquids is given approximately by the difference in their cohesive energies :

$$\Delta H = KV\left(\sqrt{\frac{E_1}{V_1}} - \sqrt{\frac{E_2}{V_2}}\right)^2 (1 - V)^2$$

where E, the cohesive energy, is given by the latent heat of evaporation :

$$E = L - RT$$

The swelling powers and cohesive energies for a number of organic liquids when brought into contact with vulcanized rubber have been found to conform to this simple idea with remarkable exactness.

NEW SYSTEM OF ELECTRIFICATION FOR BRITISH RAILWAYS

By G. H. PLATT
King's College, University of London

THE recent announcement by the British Transport Commission of its decision to adopt the 50 cycles/sec. single-phase alternating current system for future main-line electrification of British Railways is of great interest to all in the electrical industry and of far-reaching importance to the nation as a whole.

The advantages of electrically operated railways are too well known to need elaborating here ; but briefly they are :

(*a*) The greater power available enables faster services to be run and permits more frequent trains over any given track. This is most apparent in urban and suburban passenger services ; but is equally important in handling the traffic over a busy main line.

(*b*) Above some particular traffic density, the cost per ton-mile is less than with other forms of motive power.

(*c*) Very much less coal is needed than for steam traction, owing to the much greater thermal efficiency of modern power stations than the steam locomotive. Moreover, the coal used in power stations is of inferior quality, and the use of nuclear energy will further save coal.

(*d*) The absence of smoke and dirt makes for general cleanliness.

Details of the British Transport Commission's scheme have already been published (March 1956). The new system is concerned principally with main-line electrification. The London Transport Executive and Southern Region systems are unaffected. Their form of power supply is the most suitable one for underground and suburban traffic, and the cost of converting that of the Southern Region is unwarranted for the amount of locomotive-hauled traffic involved.

For ordinary long-distance main lines, however, the conditions are quite different. The use of a.c. supply for electric railways offers great advantages from the transmission point of view in that a high voltage can be used on the overhead wire, and transformed down at the point of use, that is, on the locomotive. On the other hand, an a.c. motor has disadvantages for traction compared with its d.c. counterpart. A system using a.c. of low frequency (15–25 c./s.) is in fairly wide use, but has the disadvantage of requiring its own generating plant and supply network, entirely separate from those of the public supply, or else expensive frequency-changing substations employing rotating machinery. Rotating machines for the conversion of a.c. to d.c. have long been rendered obsolete by the development of the mercury arc rectifier, and the majority of electric railways using alternating current to-day convert the a.c. supply to d.c. at 1,500 or 3,000 volts in substations alongside the tracks. With main-line locomotives this means that heavy currents have to be collected. The weight of copper in the overhead system is thus considerable, the supports must be proportionally strong and the total cost is high.

By feeding the contact wire with a.c. at 25 kV. the current to be collected is greatly reduced and the whole overhead system can be made much lighter and cheaper. In addition, substations can be placed much farther apart so that fewer are needed, and furthermore, the substations themselves are simpler and cheaper, containing only static transformers and switchgear. This is an important advantage, as the cost of the fixed installations does not vary greatly with the traffic density. Hence the use of a.c. supply may make it financially justifiable to electrify lines which would otherwise be uneconomic due to their lighter traffic.

In this connexion a special survey of the proposed Euston–Manchester–Liverpool route has shown that some startling economies will be effected by the use of a.c. This system will require twelve substations only instead of seventy for d.c., and need 68 per cent less copper and 17 per cent less steel for the overhead equipment. An additional saving in this case is that only seventeen instead of two hundred and fifty miles of 33 kV. feeder lines will be necessary to take the current from the Central Electricity Authority.

This change in supply has been made possible largely by the progress in rectifier design, which has now made it practicable to carry the rectifiers on the locomotives themselves. Those already in service mostly utilize mercury valves of the 'Ignitron' or similar type ; but successful trials have been run recently on British Railways by a motor-coach employing a germanium rectifier. This is an important advance in this field.

The new system also offers greater scope for development in design and technique than other systems. With d.c. supply, the motive power must of necessity employ d.c. motors ; but by bringing the a.c. right into the locomotive the maximum freedom is given for the development of its design. Locomotives

with rectifiers, various types of converters and straight a.c. motors are in use experimentally in France, and some of these have been found to have special advantages for certain kinds of traffic.

The low-frequency, single-phase a.c. commutator motor is considered by some to have better characteristics than the d.c. machine for main-line work, and the development of the former to operate satisfactorily on 50 c./s. has made considerable progress during the past few years in France. This type may yet become a serious rival to the d.c. series machine.

Up to now, however, the rectifier locomotive has given the most promising results, and has been found to have unexpected operating advantages over even its d.c. rival. On the Valenciennes–Thionville line, B_0—B_0 type mixed-traffic locomotives with 'Ignitron' rectifiers and having 84 tonnes adhesive weight haul freight trains of 1,400 tonnes, whereas the absolute maximum loading of a modern 1,500-V. d.c. locomotive of the same type and weight would be 900 tonnes only. This is due to improved adhesion characteristics at starting and at low speeds.

The motors used in rectifier locomotives are of the d.c. series type, specially designed to work satisfactorily on the pulsating output from the single-phase rectifiers. Biphase or 'full-wave' rectification is used, the output from which can be considered as a smooth d.c. voltage having superimposed on it an alternating e.m.f. of comparable magnitude and a frequency of 100 c./s. This introduces problems of commutation and heating in the motors; but by paying special attention to the design of the motors and including smoothing chokes in the circuit the difficulty can be overcome satisfactorily. With the ordinary d.c. system the problem does not arise, since rectifiers having six or more phases are used and the a.c. component or 'ripple' is in consequence insignificant.

The cost of the rectifier locomotive, according to the French figures, is comparable with a d.c. machine of the same rating, both in first cost and maintenance. Allowing for the improved performance, the rectifier machine shows a considerable economy in operating a given service. The use of semiconductor rectifiers in the future should show an even greater saving. The above-mentioned British survey shows that sixty fewer locomotives will be needed for these services.

The provision of sufficient clearances for a contact-line voltage of 25,000 volts is not easy in Britain. In some tunnels the cost of providing clearances would be prohibitive, and therefore it is proposed to employ a much lower voltage, namely, 6,600 volts, over certain sections, combined with the use of dual-voltage equipment.

The taking of large amounts of single-phase power from the public supply network suggests problems of unbalance on the three-phase system. Experience in France has shown that any disturbance has remained within acceptable limits, and no trouble is anticipated in Britain with its more heavily-loaded grid. The proposed scheme has the full concurrence of the Central Electricity Authority.

In addition to its major advantages, the use of a.c. supply simplifies very considerably the supply of power to locomotive auxiliaries, train lighting and heating, etc., a single transformer sufficing to provide supplies at any voltage required.

It is evident that the British Transport Commission's choice of the 50 c./s. alternating current system is based on a balanced judgment of the many factors involved. The Commission's readiness to profit by the latest technical developments is to be highly commended.

I would like to thank the Chief Electrical Engineer of the British Transport Commission for placing information relating to the proposed developments at my disposal.

A NOTABLE BIOCHEMICAL JUBILEE

IN 1906 Arthur Harden and William John Young, of the Lister Institute of Preventive Medicine, made two communications to the Royal Society of London on the alcoholic ferment of yeast juice; the first described the effect of phosphate on the rate of fermentation of glucose, and the second the separation from the juice by ultrafiltration of an inactive residue which could be re-activated by a soluble, heat-stable coenzyme in the filtrate.

Harden's experiments arose out of an attempt made with Allen Macfadyen to produce an anti-enzyme by the injection of yeast juice into animals, in the course of which it was found that normal serum increased the fermentation of glucose by yeast juice. In further experiments, Harden and Young fortunately adopted a volumetric instead of a gravimetric method, which enabled them to follow the rate of production of carbon dioxide continuously; they found that the filtrate from boiled yeast juice also increased the fermentation, with an initial rapid evolution of carbon dioxide, proportional in amount to the volume of juice added, and a prolongation of fermentation at a slightly higher basal rate. The effect was traced to the phosphates present in the juice, the extra carbon dioxide corresponding to one molecule for every atom of phosphorus added as orthophosphate; after the fermentation the phosphate was present in a form not precipitated by ammoniacal magnesium citrate, and presumed to be as an ester. The ester was afterwards identified by Young as fructose diphosphate; later, Harden and Robison found that a hexose monophosphoric ester was also formed which was shown by Robison to be an equilibrium mixture of glucose, fructose and mannose esters.

Harden and Young also dialysed the fresh juice, to find out the effect of the complete removal from the juice of the dialysable substances passing into the filtrate of boiled juice. They used for this purpose the rapid method of ultrafiltration under pressure through a filter of gelatin supported in the pores of a Chamberland filter candle, which had been devised by C. J. Martin, then director of the Lister Institute. In this way, the juice was separated into a residue and a filtrate, each of which was itself incapable of fermenting glucose, but which together fermented it as actively as the original juice. Since soluble phosphates did not activate the residue, it was concluded

that the filtrates contained a distinct factor, to which the name 'coenzyme' and later 'cozymase' was given.

Their work was simple but precise, and its very precision was perhaps a bar to their further elucidation of the phenomenon of phosphorylation. Harden perceived that inorganic phosphate was necessary for the rapid rate of fermentation, that is, the process of esterification was necessary; but it seemed that the ester formed (hexose diphosphate) could not be an intermediate, since it was only fermented very slowly by the juice. Harden and Young considered that a coupled reaction occurred:

$$2C_6H_{12}O_6 + 2HR_2PO_4 \rightarrow 2CO_2 + 2C_2H_6O + 2H_2O + C_6H_{10}O_4(PO_4R_2)_2$$

in which by the phosphorylation of one molecule of sugar the breakdown of a second molecule was induced; when all the inorganic phosphate was esterified, the rate of fermentation fell to the basal rate, dependent for a supply of phosphate on the slow hydrolysis of the phosphoric esters.

It was not until 1945 that Meyerhof showed that the two phases were due to a destruction of the adenylpyrophosphatase of yeast during the preparation of the juice, so that the coupled reaction:

3-Glyceraldehydephosphate + phosphate + cozymase $\rightleftarrows$ 1-3 diphosphoglyceric acid + dihydrocozymase

1-3 Diphosphoglyceric acid + adenosine diphosphate $\rightleftarrows$ 3 phosphoglyceric acid + adenosine triphosphate

came to a halt for lack of the phosphate-supplying mechanism of the apyrase:

Adenosine triphosphate $\rightarrow$ adenosine diphosphate + phosphate

Harden's facts, however, were incontrovertible and induced an autocatalytic fermentation in the science of biochemistry the course of which need not be recapitulated here. Though he realized the fundamental nature of his work, he was habitually restrained and would have thought it regrettable hyperbole to say to his colleague in 1906: "This day we have lighted such a candle in England as I trust shall never be put out". But it is no exaggeration to say now that their work is the source, reflected and amplified by many later workers, of our understanding of intermediary carbohydrate metabolism and many other phosphorylation mechanisms in animals, plants and micro-organisms.

IMMUNOLOGICAL TOLERANCE

A MEETING was held on March 8 at the Royal Society on the subject of "Immunological Tolerance", under the leadership of Sir Macfarlane Burnet. Following the definition of Billingham, Brent and Medawar, immunological tolerance is a specific weakening or suppression of reactivity caused by exposure of animals to antigenic stimuli before the maturation of the faculty of immunological response. In his opening paper, Prof. P. B. Medawar (University College, London) referred to the experimental demonstration of tolerance against such varied antigens as the erythrocyte agglutinogens, the tissue antigens responsible for transplantation immunity, bacterial antigens and purified proteins. Marked differences are found between the first two of these antigens: the erythrocyte antigens are stable, cytoplasmic, and elicit a transient gamma-globulin response, whereas the unstable, nuclear, tissue antigens elicit a permanent state of heightened graft resistance mediated by leucocytes rather than serum.

In contrast to the suppression of reactivity brought about by agents such as cortisone or radiation, tolerance is specific: the response to one antigen is suppressed without altering the response to others. Another essential property is that the suppression is central, acting on the tissue producing the antibody. Tolerance differs in this respect from immunological paralysis, or the enhancing of tumour growth by antiserum or tissue extracts. A comparable specific and central suppression of the immunological response has been demonstrated by Chase in the inhibition of sensitization to simple organic compounds by prior oral feeding. Medawar then returned to the subject of the biological implications of immunological tolerance[1].

In a paper on "Erythrocyte Antigens and Tolerance Phenomena", R. D. Owen (California Institute of Technology) drew two conclusions from his earlier work on stable erythrocyte mixtures in twin cattle. From the observation that the antigenic types derived from each twin occur in equal proportions in the blood of each twin, it follows that no selective pressure is exerted in favour of hæmatopoietic tissue of native origin, and that tolerance is therefore complete. From the observation that no more than two types of cell are found in twins which differ by several antigens (with the exception of *J*), it follows that sub-cellular transformations do not occur, and that hæmatopoietic cells are in this sense fully autonomous. Attempts to mimic the chimerism of twin cattle in rats by means of parabiosis have been unsuccessful; but Ripley has produced a similar condition by injection of embryonic rats with embryonic liver and spleen cells through the chorionic blood vessels. Chimeras have also been produced in rats after injection of hæmatopoietic tissue into irradiated recipients, by Lindsley, Odell and Tausche. Owen then described his own work on acquired tolerance in man, where past exposure to *Rh* antigens *in utero* weakens the adult antibody response. *Rh*-negative women who complete three or more *Rh*-positive pregnancies without developing antibodies tend to have *Rh*-positive mothers. This tolerance is, however, not associated with a reduced incidence of erythroblastosis. Owen finally described an effect of injection of human erythrocytes into new-born chickens. The antibody response of the recipients as adults is delayed, weakened and tends to the production of incomplete antibody.

B. Cinader and J. M. Dubert (Lister Institute and Institut Pasteur) gave an account of their joint work on "Specific Inhibition of Response to Purified Protein Antigens". New-born rabbits were injected with highly purified human albumen, and litter mates left as controls. When challenged with the same antigen as adults, the controls produced antibody detectable by a gel-diffusion technique, and also by agglutination of tanned erythrocytes coated with antigen. The animals injected at birth failed to produce antibody, constituting an example of actively acquired tolerance. Tolerance of the injected animals

was also exhibited in experiments with human albumen labelled with radioactive iodine. The labelled protein was eliminated slowly and continuously from the tolerant animals, in contrast to the controls, which exhibited a sharp rise in the rate of elimination as the immune response developed. Tolerance in this instance was shown to be specific, by means of cross-tests with tobacco mosaic virus and also diazotized human albumen. The diazotized human albumen provides a refined demonstration of specificity, since it is an antigen which normally elicits antibodies of two distinct types, specific either for the diazo group or for the albumen. Those tolerant animals which responded to the diazotized human albumen produced antibody only against the diazo group, as could be shown by absorption tests with human albumen. In a single animal, administration of diazotized human albumen appeared to weaken the tolerance to normal albumen, indicating that the state of tolerance can itself be modified experimentally.

Applications of immunological tolerance were described in papers entitled "Tolerance of Ascites Tumour Cells", by H. Koprowski (Lederle Laboratories, New York), and "Acquired Tolerance of the Rous Sarcoma Agent in Turkeys", by R. J. C. Harris (Chester Beatty Research Institute). Koprowski was able to obtain, from two transplantable mouse lymphomas, lines that would grow in normally resistant mouse strains; and from a rat hepatoma he obtained a line which would grow in mice. The transformation was made by inoculation of tumour cells into unborn mice of the prospective host strain, thus inducing a state of tolerance which enabled the tumour to grow progressively. The tumour masses which developed after birth served to start the transformed line of tumour, if necessary re-inoculating fœtal mice to complete the transformation. The adaptation of the transformed tumour lines to their new hosts was incomplete, as judged by the dosage of tumour cells needed to kill the new hosts as compared with hosts of the strain of origin. The transformed mouse-tumour lines appeared to retain antigens characteristic of their strains of origin, as indicated by adoptive immunization tests. The rat tumour retained the characteristic rat *V*-chromosomes, and could be transplanted back into rats. In tests with a variety of animal viruses, the transformed-tumour lines appeared to provide better hosts for virus multiplication than the original lines, and to be more susceptible to oncolysis by viruses.

Turkeys which had been rendered partially tolerant to chicken antigens were used by Harris, in an attempt to separate the Rous sarcoma agent from chicken antigens. If inoculated soon after hatching with chicken antigens, a proportion of turkeys are rendered susceptible to the Rous sarcoma virus and other non-virus chicken sarcomas. Live blood cells, blood cells killed by freezing or heating, or skin grafts, are all active for this purpose as chicken antigens. While growing in susceptible turkeys, the Rous sarcoma progressively loses its content of virus infective in chickens. This may indicate a conversion of the virus to the turkey antigenic type; but since virus assays were not also carried out in turkeys, it may instead indicate a decrease in the virus content of the tumour cells. After a single passage back into chickens, the sarcoma regains its full content of virus infective in chickens.

Parallel papers were presented by M. Hašek (Czechoslovakian Academy of Science) on "Tolerance Phenomena in Birds", and by R. E. Billingham and L. Brent (University College, London) on "Analysis of Tolerance induced in Newly Hatched Turkeys and Chicks". Work in London and Prague has shown that tolerance is readily produced in birds by the introduction of foreign cells into the embryo, intravenous injection and parabiosis being particularly effective methods. Hašek concentrated on the manifestation of tolerance as a suppression of hæmagglutinin production, and Billingham and Brent as a prolongation of the survival-time of skin grafts. In order to weaken or suppress reactivity to skin homografts, Billingham and Brent find that live, nucleated cells are essential. According to the criteria of hæmagglutinin suppression and prolonged graft survival, tolerance is produced more readily within than between species. The combinations of species tested were between chicken, turkey, duck, pheasant, goose, guinea fowl and pigeon. As expected on Darwinian principles, they find that tolerance produced between some strains of poultry is weaker than between others. The degree of tolerance which could be produced between species appeared to vary in accordance with their systematic relationship.

Induction of tolerance by intravenous injection of antigens into new-born chickens or mice was also described by Billingham and Brent. This method proved to be more economical than injection into the embryo. Nearly half the chickens injected with blood from another strain exhibited a degree of tolerance, although only a small proportion of skin homografts on new-born chickens take permanently. This discrepancy is ascribed to the delay in vascularization of the grafted skin.

[1] *Nature*, **176**, 852 (1955).

OBITUARIES

Prof. F. Riesz

The distinguished Hungarian mathematician, Friedrich (Frigyes) Riesz, died recently. He was born on January 22, 1880, at Györ, and studied at Zurich, Budapest, Göttingen and Paris, taking his doctor's degree at Budapest in 1902. In 1911 he was appointed to a supplementary professorship at Kolozsvár (Cluj), becoming Professor Extraordinarius in 1912 and Professor Ordinarius in 1914. In 1919 Riesz moved with his university to Szeged, and in 1945 he was appointed to a chair in Budapest. In 1922 he became editor of a newly founded periodical, the *Acta Scientiarum Mathematicarum* of Szeged, which quickly established a distinguished place for itself among the world's mathematical journals.

Riesz was one of the pioneers of functional analysis, and we owe to him many of the fundamental ideas of the subject, which were later incorporated in an axiomatic formulation by S. Banach and his collaborators. Riesz's principal contributions may be summarized as follows: the Riesz–Fischer theorem (1907) on the equivalence of Hilbert's space of sequences of convergent sum of squares with the space of functions of summable square, which is the mathematical basis of the equivalence of matrix

mechanics and wave mechanics; the Stieltjes integral representation for linear functionals on the space of continuous functions (1909); the theory of L^p spaces (1910); the first systematic discussion of analytic functions of operators (1913); the definition and properties of general completely continuous operators (1916); and the foundation of the theory of partially ordered vector spaces (1928). In 1952 there appeared the "Leçons d'analyse fonctionnelle", written jointly with B. Sz.-Nagy, and easily the most readable introduction to functional analysis that has yet appeared.

Riesz constantly strove to simplify the presentation of the theory of the Lebesgue integral; he introduced the systematic use of step functions (1912), and he proved (1931) the famous 'rising sun lemma', which leads to an easy proof of the differentiability almost everywhere of a monotone function.

He was one of the creators of the theory of subharmonic functions. Other fields to which he contributed include the theory of functions analytic in the unit circle, orthonormal series, inequalities and ergodic theory. He gave several proofs of the fundamental spectral theorem in Hilbert space. An early paper (1908) on topology contains ideas (bicompactness, the filter theory of limits) that had to wait until the late 1930's for their full development.

Riesz's work is characterized throughout by simple and powerful ideas and by lucidity of presentation; his papers are always easy to read. He never generalized for generalization's sake; his aim was always to put the main ideas in a setting that would illustrate their significance and their power as vividly as possible. F. SMITHIES

Dr. Eugene C. Crittenden

EUGENE CASSON CRITTENDEN, formerly associate director of the United States National Bureau of Standards and for many years chief of its Electrical Division, died in Garfield Hospital, Washington, D.C., on March 28 at the age of seventy-five.

After graduating in 1905 and a period of postgraduate work and teaching, all at Cornell, Dr. Crittenden joined the National Bureau of Standards in 1909 and was assigned to the photometric laboratory, where he was afterwards to make many important contributions towards the establishment of modern photometric units, standards and methods of measurement. During 1921–46 he was chief of the Electrical Division and thus also became responsible for work which, in collaboration with other national laboratories, led to the replacement of the obsolescent system of international electrical units by the present system of absolute electrical units. Under his leadership the Division expanded substantially, and sections for research in radio and electronics were established which eventually became major organizational units of the Bureau—for example, the Central Radio Propagation Laboratories at Boulder, Colorado, and the former Ordnance Development Division, now the Diamond Ordnance Fuze Laboratories of the Department of the U.S. Army. In 1933 Dr. Crittenden was made assistant director of the Bureau and became concurrently responsible for supervision of its over-all research and testing activities; and in 1946, when the title was changed to associate director, he assumed the full-time responsibilities of this post, which he held until he retired in 1950. For his outstanding services to the Bureau he was awarded in 1949 one of the first Gold Medals of the Department of Commerce for Exceptional Service. He continued to act as a consultant to the Director of the Bureau until the onset of his last illness a few months ago.

Dr. Crittenden is best known both in his own country and internationally for his many activities and services which, combined with those already mentioned, played an important part in the developments which led to the international adoption in 1948 of the present electrical and photometric units and standards. He was vice-president of the International Commission on Illumination during 1939–48 and president of its U.S. National Committee from 1928 until 1935. During 1946–54 he was the member for the United States on the International Committee of Weights and Measures, of which he was vice-president from 1950 until 1954, and he had been a member of this Committee's advisory body for electricity and photometry since 1933. He also participated in the work of the International Organization for Standardization and the International Committee of Legal Metrology. Dr. Crittenden was for many years on the Standards Council of the American Standards Association, of which he was chairman during 1945–48, and in his time he served as president of the Illuminating Engineering Society, the U.S. National Committee of the International Electrochemical Commission and the Optical Society of America, as well as associate editor of the *Review of Scientific Instruments*. He also participated in the work of the American Society for Testing Materials, the American Institute of Electrical Engineers, the American Institute of Physics and the National Research Council.

Dr. Crittenden will long be remembered by his former colleagues on international committees, for he always brought to their deliberations wise counsel based on great knowledge and experience and expounded with good humour. Photometry was the primary interest which eventually led him to become a renowned exponent of international collaboration in all matters concerned with metrology. He is survived by his wife, formerly Norma M. Snyder, a daughter and a son. H. BARRELL

Dr. A. L. Stern

ARTHUR LANDAUER STERN died suddenly on April 26 at Chorley Wood at the age of eighty-eight. He was born on May 6, 1867, the eldest of seven children of Moritz and Fanny Stern, of Birmingham. At King Edward VI High School he was a Foundation Scholar; and in 1887 from Mason College he obtained honours B.Sc. (London). He was then Tangye Research Scholar and personal assistant under Sir William Tilden, working on compounds of phosphorus. After that, under Dr. Cornelius O'Sullivan, he worked on chemical problems of fermentation and brewing, and soon became chemist and brewer at Messrs. Bass, Ratcliffe and Gretton, under O'Sullivan. An early piece of work was to show that glucose from various sources was the same substance, and thus he helped to lay one of the foundation stones of modern organic chemistry. He obtained his D.Sc. (London) in 1894.

On the death of O'Sullivan in 1906, Stern succeeded him as head brewer at Bass's New Brewery. He reorganized the research, with prescience concentrating on the biological side (Dr. Arthur Slator was then his chief assistant). Under his direction, the rate of multiplication of yeast cells was shown to be

subject to simple mathematical laws. On the industrial side, a series of researches revolutionized the maturation of beer. It is forty years since Stern substituted metal tanks with single-feed cylinders in the racking room instead of the old single wooden casks; and his method has now become standard practice. Many technical processes were influenced by him, from the better use of fuel in breweries to the bottling of beer and its dispatch overseas so that "Bass" should arrive in perfect condition in diverse climates. Incidentally, he, under O'Sullivan, brewed the famous King's Ale of 1902.

Stern's brewery was a happy place. He was not only a master brewer, but also had happy relations with his staff, and took a personal interest in them and their families. He was a man of wide interests, and although he retired early, he never lost contact with scientific affairs.

He had a very happy married life, saddened only by his wife's death last year. He leaves seven children, all of whom went to universities, four of them following scientific careers; his eldest grandchild is about to enter Cambridge to read science.

Mr. Harold Picton

Harold Picton, who died on March 21 in his eighty-ninth year, will be remembered for his contributions to science, education and international understanding.

Picton was a son of the Rev. J. A. Picton, Unitarian minister and M.P. for Leicester, and grandson of Sir James Picton, of Liverpool. After graduating at University College, London, he worked in Sir William Ramsay's laboratory. With S. E. Linder he published a series of papers on colloidal solutions. Sols of arsenious sulphide were prepared in various grades down to one in which the submicroscopic particles passed through porous pot and diffused, yet still scattered light, giving the Tyndall effect. Picton and Linder were the first to show the migration of such particles in an electric field, the arsenious sulphide moving to the anode and ferric hydroxide to the cathode. They studied the precipitation of these sols by electrolytes and showed the presence of the positive ion in the precipitated arsenious sulphide. The efficiency of the electrolyte as coagulator was also related to the charge on the positive ion. This is known as the Hardy–Schulze Law, but, as Prof. W. C. McC. Lewis wrote, it "might perhaps more legitimately be known as the Schulze–Linder–Picton–Hardy Law". This work undoubtedly laid the foundation of much of the modern view of suspensoid colloidal systems.

In 1900, after a few years as science master at Parmiter's School, Picton joined his friend, the Rev. J. E. Bennett, who had opened a small residential school, Clacton College, and shortly afterwards he succeeded him as headmaster. This was a remarkable school which anticipated many modern trends in education. A family spirit was developed both in and out of the classroom. Discipline was strict but kindly, and was based on rules laid down by an elected school council. The physical, mental and spiritual aspects of personality were provided for in a well-balanced whole. Games were played but were not over-emphasized, and boys were encouraged to take up other interests such as gardening, photography, and the study of church architecture and of prehistoric remains. A number of worked flints and mammalian bones and teeth were collected from the Pleistocene deposit on the Clacton foreshore and this section of the school museum was afterwards presented to Charterhouse School.

From his mother (née Jessie C. Williams), who was brought up in Hamburg, Picton acquired a deep love of Germany. From 1914 onwards he strove to promote a better understanding between the Germans and the British. In five books published between 1918 and 1948 and many other writings he stressed the better elements in German life and culture. His "Early German Art and its Origins" (1939) was an important work. For six years he lived near Berlin but returned to England in 1934 after the rise of Hitler. From that time he exposed the horrors and dangers of the Nazi dictatorship; but always insisted that the whole German nation should not be condemned for the crimes of the Nazis. He worked untiringly to help refugees from Germany.

Harold Picton was a man of vigorous and many-sided personality to whom men were more important than systems. He had a genius for friendship and he gained the affection as well as the admiration of his pupils, who will never forget the debt they owe him. He did not marry but adopted a son, who survives him.

G. M. Bennett

Dr. Harry J. Deuel, jun.

Dr. Harry J. Deuel, jun., whose death at the age of fifty-eight occurred on April 17, had been an active force in the field of nutrition for more than a quarter of a century, his major interest being the biochemistry of lipids. His group at the University of Southern California has established a vast amount of biological data on the digestibility of fats and the lipid composition of the tissues of different animals under varying experimental conditions. This quantitative information has been, and will continue to be, of great value to innumerable workers in this field.

It is not only as an accumulator of facts that Dr. Deuel will be remembered; he also made notable contributions to advancing knowledge, especially in connexion with the composition of cerebrosides, the conversion of carotene to vitamin A, the nutritional importance of dietary fat and the effect of hormones on lipid metabolism. He had a wide knowledge and interest in all work in the lipid field, and many will recall happy hours of argument and discussion in which he took a leading part. This width of experience found expression during the past few years in his writing "The Lipids; their Chemistry and Biochemistry", two volumes of which have already been published. The third and last volume was nearing completion at the end of last year. This work is likely to become established as a standard work in this field—a fitting memorial to its author.

Harry Deuel took great delight in meeting people. As a Fulbright Fellow at Cambridge during the past year, he was able to renew many old friendships and to make many new ones. He carried through an active programme of lectures and visits, both in Britain and on the Continent. Those who had the privilege of meeting or hearing him during this past year will find inspiration, not only from the scientific contributions he made on many occasions, but also from his immense courage and fortitude. He was a man that so many of us were happy and proud to have known.

A. C. Frazer

NEWS and VIEWS

Anatomy at Cape Town: Prof. M. R. Drennan

After forty-three years of almost continuous service to the University of Cape Town, Prof. M. R. Drennan retired from its chair of anatomy at the end of 1955. He arrived in South Africa from Ayrshire in 1913, the year of the first discovery of a fossil human skull, the Boskop skull, in South Africa, and no single personality has impressed his stamp more profoundly upon the first medical school to be established in South Africa. Not only as a contributor to Cunningham's "Anatomy", but also as the author of his own concise text-books on osteology, embryology and physical anthropology, his name is familiar to medical students throughout the Commonwealth. Among some thousand registered medical graduates directly influenced and inspired by his teaching are such figures of eminence as Thomas J. Dry, of the Medicine Section of the Mayo Clinic, Sir Solly Zuckerman, of Birmingham, and David Slome, of the Royal College of Surgeons of England. Amid the spectacular South African discoveries in physical anthropology of his generation, Drennan's shine with characteristic brilliance. His recognition of the Boskop fossil type as still extant in a Hottentot being dissected (1924), of the Australoid fossil skull from the Cape Flats (1929), of pedomorphism in the pre-Bushman Plettenberg Bay skull (1931), of the Neanderthaloid features in the Florisbad skull (1935) and of the Rhodesian affinities of the Saldanha Bay skull (1953) are classical contributions to prehistory. His collection of extant, recent and fossil human material from the southern extremity of the Old World land mass established a crucial centre of research that has been steadily illuminating human anatomy and history in Africa from the Middle Stone Age to the modern era. In approximately a hundred publications, Drennan's originality has ranged over topics historical and educational as well as the more strictly anatomical and surgical. As past president of the South African Archæological Society, member of the Historical Monuments Commission from its inception, fellow and council member of the Royal Society of South Africa, director of the South African Museum and in numerous other professional and public capacities, he has given and will doubtless continue to give unremitting service in many capacities to South African science.

Prof. L. H. Wells

Dr. L. H. Wells, who succeeds Prof. M. R. Drennan, is returning to South Africa, whence he went as senior lecturer in physical anthropology to the Department of Anatomy at the University of Edinburgh in 1951. Educated at St. John's College and the University of the Witwatersrand at Johannesburg, he showed an early leaning towards anatomy by graduating M.Sc. with a thesis entitled "The Foot of the South African Native", and by his appointment first as a graduate demonstrator and later as a junior lecturer in anatomy, prior to taking his medical qualification, by which time he already had a number of publications to his credit. His early interest in physical anthropology and human and comparative palæontology, stimulated by the head of the Department of Anatomy at Johannesburg, Prof. R. A. Dart, and by the work of the late Robert Broom, has continued unabated to the present time, being recorded in a long series of papers which report the results of studies on a wide variety of subjects ranging from the peroneus tertius muscle of the baboon and the anatomy of the Bushman to human remains of the Dark and Middle Ages in south-east Scotland. The appointment of an anthropologist of Dr. Wells's calibre to the chair at the University of Cape Town will undoubtedly further the study of anthropology in Africa, while bringing him into closer touch with the important discoveries of fossil primate remains which continue to be made on that continent.

The Perkin Centenary

To mark the centenary of W. H. Perkin's discovery of the first synthetic dye, the *Manchester Guardian* has included a supplement in its issue of May 7 in which various contributors discuss the many developments that have resulted from this great event made when organic chemistry was still in its infancy. The first article is a personal recollection of Perkin by his nephew, Mr. Arthur H. Waters, who relates how he can remember his uncle back to about the year 1880 (when Mr. Waters was six years old). The article is a charming reminiscence of a man who, though his name to the outside world was illustrious, was to his kith and kin a simple, kindly soul—a religious man deeply interested in social welfare, temperance and evangelism; a great lover of children; a vegetarian; a keen recruit to the ranks of bicyclists in the early nineties; and a man who scarcely ever mentioned chemistry in the family circle. Mr. Waters's contribution is followed by one by Prof. W. Bradley (Department of Colour Chemistry and Dyeing, University of Leeds) on Perkin's scientific work and life. Two more articles continue in the biographical vein: "The Perkin Family and the Textile Industry", by R. G. Fargher (director of research and development, Samuel Heap and Son, Ltd.), in which are discussed the parts played in the textile industry by two of Perkin's gifted sons, namely, William Henry and Arthur George; and "Pullar and the Dyers' Reaction", by J. L. Crockatt (director and general manager, J. Pullar and Sons, Ltd., Perth), in which is retold the story of Perkin and the young dyer, Robert Pullar, of Perth. The remaining three articles deal with the more modern industries that have grown up as a result of Perkin's work. Under the heading "A More Fragrant World", Paul F. Spencer (chief chemist, Cusson Sons and Co., Ltd.) discusses synthetic odours and flavours, and in a rather longer article, "Raw Materials derived from Coal", L. W. Blundell (president of the National Benzole and Allied Products Association) writes on the importance of the residues from gas-works. The last, and longest, article is by Frank L. Rose (research manager, I.C.I. (Pharmaceuticals), Ltd.) on "Perkin's Influence on Medicine: the Development of Drugs and Antibiotics", a field in which the name of Ehrlich, working first with methylene blue and congo red, stands head and shoulders above the rest. Of all the lines developed from Perkin's dye, this is perhaps the one in which the most amazing developments have been made; certainly it has been the one most beneficial to mankind.

Supply of Scientists and Technologists in Britain

In his presidential address to the Institution of Chemical Engineers on "The Technological Awakening", given on April 24, Mr. J. A. Oriel welcomed the Government's new awareness of the value of technology, which he thought was due largely to the

work of the chemical engineer during the past thirty-five years, and he urged that the situation should be examined constructively and with a view of helping rather than of controversy. He deprecated controversy over the relative merits of an education in the arts or in the sciences. This is a passing phase, although at present there are too many scientific illiterates, and it is regrettable that we should not have at the head of affairs, at a time of great technical improvements, more men with technical imagination capable of inspiring those working under them. Nor did Mr. Oriel think there is much advantage to be gained by comparing the position in Britain with that in the United States and the U.S.S.R. We do not wish to follow the U.S.S.R. in forcing men to adopt scientific or technological careers; but we cannot deny that we force men into National Service, and the Government has not grasped the seriousness of diverting from their profession when they are badly needed those chosen because of their ability for special training in science and technology.

Mr. Oriel thinks that the number of boys reading science has already increased, and that the quality will also improve. He believes that the technological sub-committee of the University Grants Committee will provide the necessary guidance and impetus to technological education, but pointed out that the universities can help to improve the status and outlook of teaching staff in the technical colleges by inviting their assistance in research and allowing more research carried out at the technical colleges to rank for the preparation of Ph.D. theses. He also suggested that universities hold on to their graduates too long; a university should retain only a very small number of those who have obtained their first degree, and only then after satisfying itself that they are really men who will benefit by a period in research, which normally, Mr. Oriel suggested, should be pursued at a different university. In general, the undergraduate after three or four years should move into industry or teaching, and those clearly designed for first-grade technologists should move elsewhere to a college also open to men who had already spent from two to five years in industry. In such institutions we may expect to find the interchange of ideas and techniques that will really make Britain a leader in quality of technologists. As regards the technical colleges, where the expansion in technical education will come, Mr. Oriel pointed out that the municipal or regional patriotism of the local education authority can be a source of strength as well as a weakness, and he appealed for full support of the 'sandwich' system by members of the Institution who as managers are in a position to help. Given such support and a right attitude by parents, teachers and university professors as well as industry, Mr. Oriel sees no reason why Britain should not double its output of well-trained scientists and technologists within five years.

Physical Society's Handbook of Scientific Instruments and Apparatus

The "Handbook of Scientific Instruments and Apparatus, 1956 Exhibition", published in connexion with the fortieth annual exhibition of scientific instruments and apparatus of the Physical Society, to be held in the Halls of the Royal Horticultural Society, London, during May 14–17 (see *Nature*, April 7, p. 653), is not only a detailed catalogue and guide to the exhibits but is also a valuable reference book and useful indication to recent progress and development in the design and production of British scientific instruments and apparatus (pp. xvi+257+88; from the Society, at 1 Lowther Gardens, Prince Consort Road, London, S.W.7; 6*s*. or 7*s*. 6*d*. by post). It is arranged in the numerical order of the stands, totalling 131, which this year are to be housed in both the Old and New Halls of the Horticultural Society, thus giving much-welcome increased space for the display and demonstration of the exhibits. The exhibitors include, as formerly, government research establishments, universities, and scientific and technical publishers, in addition to about ninety-five manufacturers of scientific equipment. A brief description is given in the handbook of each particular item to be exhibited, in many cases also accompanied by an illustration, and a note is added to show whether the instrument or apparatus to be demonstrated is merely a prototype, is in production or can be made to order. The excellent indexes of both exhibitors and exhibits which preface the handbook will be found to be most helpful to users. To those who are unable to visit the exhibition, the handbook can be recommended as a comprehensive catalogue of modern physical apparatus and a quick reference book to the leading manufacturers. The advertisement section alone, consisting of eighty-eight pages, is in itself a most valuable collection of interesting information.

British Chemical Engineering

The first number of *British Chemical Engineering* is attractive and readable (Drury House, Russell Street, London, W.C.2). There is always a place for commercial journals in engineering, which is commercial itself in essence. They will be read by engineers if they contain the news. The news is not solely a matter of research work, but of developing ideas, new emphasis, new invention and the plain story of what the other man is doing. The development of ideas in chemical engineering has shown a change since the War. The straight classification of techniques into unit operations has yielded to an insistence on fluid flow, heat and mass transfer as fundamental to them all. The strength of present design methods is shown in the first article on achievements at Windscale. These were made (and made better according to Sir Christopher Hinton) without benefit of pilot plant. This view is also put forward by Lincoln T. Work in the last article. The leader and editorial comments are well written and well informed. The criticism levelled at the lack of chemical engineering research in government stations is not founded on a careful study of the work going on, but on the annual report of the Department of Scientific and Industrial Research, which is condensed. Other articles are of a good standard and the features well planned. This is altogether a professional production and will need to maintain a level to justify a title which involves so much.

Nematologica: New Journal of Nematological Research

A new international quarterly journal of nematological research, *Nematologica*, has been founded through the initiative of Dutch workers, after informal discussion among some of the participants at the third symposium on plant nematology, held at Wageningen in July 1955. The editorial board

consists of J. H. Schuurmans Stekhoven, J. W. Seinhorst, M. Oostenbrink, and P. A. van der Laan, of the Netherlands; they are assisted by advisory editors from fourteen countries, including the United States and the U.S.S.R., with F. G. W. Jones and B. G. Peters from Great Britain. The first issue (1, No. 1; 1956. Pp. 80+10 plates. Leyden: E. J. Brill; 28 florins per volume of four parts) contains about half the communications to the above symposium, and the second is to contain the remainder. The editors state that, in consequence, these two issues will not be representative of future issues, for the communications were all relatively short and most of them in the field of agricultural nematology. Although future issues are to be concerned primarily with this aspect, it is hoped that the journal will cover the field of nematology in general, "except for papers on medical and veterinary subjects", and will also include studies in "taxonomy, physiology, morphology, genetics, and other more fundamental research". The journal also incorporates the *Nematological News* of Dr. A. H. Meyl (Germany); in the first issue, two pages of small print are devoted to this very useful feature.

Geographical Trends in the Soviet Union

In the September issue of the Russian journal, *Nauka i Zhizn* (Science and Life), K. V. Zvorykkin and G. M. Ignat'ev emphasize the importance of a closer connexion between geographical exploration and agriculture, as exemplified by some recent surveys by the Geography Department of the University of Moscow. Both geology and geography, they write, must to-day subserve strictly practical and utilitarian ends, with perhaps less of the glamour and adventure that enlivened the exploits of old. The former must be used for seeking far and wide for new oilfields or promising formations, and the latter for exploring throughout the length and breadth of the vast Soviet territories for more farmland to meet the rapidly increasing needs of a growing population and rising standard of living. However, the surveys they describe did not go very far afield: they went no farther, indeed, than Ryazan, which is practically in the Central Russian or Moscow region, and is not so very distant south-east from the University itself. The expeditions were mainly intended as practice and experience in agricultural survey work for the students and others, more particularly on existing or potential collective farms and the domains of the tractor service stations usually associated with several of such farms. State farms, too, were included. The first expedition was mainly confined to Zaraisk, a district of the Ryazan Government, and the second was called the Ryazan Expedition, though it too was limited to a relatively few collective farms in the Sapozhkovsk locality. Both aimed at providing as much information as possible from the point of view of the potential farmlands, including detailed maps, soil science, climatology, contours and water supply, and also some indication of the measures needed to make the land suitable for cultivation and optimum use. Though students from many other departments in the University took part—physical and economic geographers, geophysicists and cartographers, soil geographers, biogeographers, etc.—it would seem that the services of economic botanists, entomologists, and even zoologists and scientific stock-breeders would be needed to make a complete and really informative study, and these are not mentioned (unless included under biogeographers). Zvorykin and Ignat'ev are firmly convinced that, in conformity with the far-reaching and ambitious economic planning for Soviet industry and agriculture, as set forth in some detail at each succeeding plenary session of the Central Committee, geographers must considerably broaden their ideas; they must even extend the range and variety of their work beyond that of agricultural requirements to the industrial field generally, for example, in surveying suitable river sites for hydroelectric stations.

Forest Products Research during 1954

The annual report for 1954 of the Forest Products Research Laboratory, Princes Risborough (pp. 60+8 plates. London: H.M.S.O., 1955; 3*s.* 6*d.* net), shows that the scope and nature of the work undertaken have remained the same; the contact between the Laboratory and the trades and others interested in the utilization of timber and its products have been close, and the number of inquiries reaching the Laboratory is still on the increase. One significant change in the work has been a decrease in the emphasis on the testing and assessment of new Colonial timbers which has formed such an important and valuable part of the work of the Laboratory during past years, more time having been devoted to the examination of various species of home-grown timber in co-operation with the Forestry Commission. Now that the new plantations are reaching a size when thinnings can be made in them, the strength or degree of these thinnings in various species of crops is undergoing sylvicultural experiment. As the work proceeds, with the increase in age and size of the wood, the Laboratory will be able to give valuable assistance in testing the timber quality of the various species being used, the soils on which they are grown and various other locality factors, including the management applied. Tests of timber seasoning and important plywood experiments are under investigation. The Entomology Section reports the discovery of the house longicorn beetle in Surrey a few years ago. It is a menace to softwood structural timbers and is well known on the Continent of Europe. So far, in spite of careful investigation, it has only been found in a comparatively restricted area in Surrey. It is said to attack the hardwood oak in Great Britain. The death-watch beetle has been under study for some time in the Section.

Australian Earthworms

The longest earthworm in the world, *Megascolides australis*, is found in Gippsland, Australia, and grows up to eleven feet in length. Its habit of 'squirting' has been described by Elizabeth C. Pope (*Austral. Mus. Mag.*, **11**, No. 12; December 1955). When disturbed, the worm squirts out a series of pairs of jets of fluid from a line of pores opening down each side of the body. The effect can be most spectacular, for these jets rise as high as eighteen inches or two feet into the air. Although there are reports that the fluid has a corrosive action, it is only slightly alkaline and contains some dissolved salts, body wastes like urea and some proteinous materials and cells. The fluid comes from the worm's body cavity and is squirted out by violent contractions of the body-wall which force the fluid out under great pressure through the pores. There is no record of the fluid having anything but a mildly irritating effect on the skin of human beings. The fluid is used for lining or lubricating the burrows of the worms. The article also refers to other 'squirter' earthworms.

Barley Mutants

T. Lawrence (*Canad. J. Bot.*, 33, 6, 515; 1955) has described the production of mutations by irradiating Montcalm barley in different ways. Five radiation sources were used for inducing mutations in barley, all treatments being given at a dosage of 10,000 r. equivalent. The radiation sources with their respective dose-rates in the region of the irradiated seeds were: a betatron (181·8 r./min.), an X-ray machine (201 r./min.), radium–beryllium (5·3 r./min.), and two cobalt-60 sources (4·5 r./min. and 75·75 r./min.). None of the radiation sources used was more effective than the X-ray treatment in producing mutations. The betatron and the high dose-rate treatments from cobalt-60 appear to be somewhat less effective than X-rays. More than thirty different mutant types were produced, including a number of vital mutants, such as stiff-strawed and early-maturing types. These appear promising as new varieties, but require further agronomic evaluation.

University of Birmingham: Appointments

Dr. N. A. Dudley, lecturer in engineering production in the University of Birmingham, has been appointed reader in engineering production and head of the Department of Engineering Production for a period of three years. The following have been appointed to lectureships in the University: T. K. Chaplin (civil engineering), Dr. T. B. Massalski (physical metallurgy), R. B. Hoole (mining) and Dr. J. N. Hawthorne (pharmacology). The following members of staff of the National Vegetable Research Station, Wellesbourne, have been appointed recognized lecturers in the University: D. W. Wright (attached to the Department of Zoology) and Dr. W. G. Keyworth (attached to the Department of Botany).

Royal Institution: Officers

The following have been elected officers of the Royal Institution: *President*, Lord Brabazon of Tara; *Treasurer*, Mr. W. E. Schall; *Secretary*, Mr. S. Robson; *Managers*, Dr. T. E. Allibone, Mr. E. R. Davies, Sir Alfred Egerton, Dr. A. G. Gaydon, Mrs. H. K. Hawkes, Brigadier H. E. Hopthrow, Mr. L. B. W. Jolley, Dr. H. Lowery, Mr. J. A. Oriel, Prof. H. J. Plenderleith, Dr. J. H. Schulman, Mr. P. H. Schwarzschild, Dr. R. Seligman, Dr. C. Keith Simpson and Prof. W. D. Wright; *Visitors*, Lieut.-Colonel S. J. M. Auld, Mr. F. G. Brown, Mr. R. C. Chirnside, Dr. F. H. Cotton, Mr. H. W. Cremer, Miss E. H. Jebens, Dame Kathleen Lonsdale, Mr. G. Parr, Mr. J. D. Peattie, Dr. R. Scott Russell, Miss Daphne Sidebottom, Dr. P. C. Spensley, Mr. W. R. Stevens, Mr. S. A. Stigant and Dr. D. T. A. Townend.

Institute of Petroleum: Officers

The following have been elected officers of the Institute of Petroleum for 1956–57: *President*, Rt. Hon. Lord Geddes; *Past-Presidents*, Lieut.-Colonel S. J. M. Auld, T. Dewhurst, Dr. A. E. Dunstan, E. A. Evans, Prof. F. H. Garner, H. S. Gibson and C. A. P. Southwell; *Vice-Presidents*, Dr. E. B. Evans, A. C. Hartley, E. LeQ. Herbert, R. B. Southall and E. J. Sturgess; *Honorary Treasurer*, G. H. Coxon; *Honorary Secretary*, C. Chilvers; *General Secretary*, D. A. Hough; *Editor*, George Sell; *New Member of Council*, M. E. Hubbard.

Annual Meeting of the Society of Chemical Industry

In addition to the lectures to be given at the seventy-fifth annual meeting of the Society of Chemical Industry during July 9–15 (see *Nature*, March 31, p. 609), a number of visits will be made to factories and research organizations in the London area. They include the Paint Research Station at Teddington, the National Institute for Medical Research, the Central Electricity Authority (Bankside Generating Station), Glaxo Laboratories, the Isle of Grain refinery of Shell-Mex and B.P., and the Atomic Energy Research Establishment at Harwell. The meeting begins with a reception on the Monday evening at Guildhall by the chairman, Sir Charles Dodds, and Lady Dodds, and the annual general meeting will take place the next day. The annual dinner will be held on the Wednesday at the Dorchester Hotel.

South-Eastern Union of Scientific Societies: Congress in Tunbridge Wells

The sixty-first congress of the South-Eastern Union of Scientific Societies will be held during May 24–27 in Tunbridge Wells, the town where the Union first met in 1896. The president-elect is Dr. W. E. Swinton, chief scientific officer of the British Museum (Natural History), whose address, "Nature and the Free Mind", will be given on May 25. In the various sections of the Union, addresses will be given by the following: *Archæology*, Major J. M. T. Burchell (the archæology of the Medway Estuary); *Botany*, Prof. C. T. Ingold (Gasteromycetes or Nature tries again); *Geology*, C. Fagg (swallow holes in the Mole Gap), and Prof. S. W. Wooldridge (geomorphology of the central Weald); and *Zoology*, Prof. H. R. Hewer (the importance of keeping field records). Further information can be obtained from the honorary local secretary, Mrs. H. Vernede, Carlton House, Carlton Road, Tunbridge Wells, Kent.

Tenth International Congress of Entomology, Montreal

The Tenth International Congress of Entomology will be held in Montreal during August 17–25, the meetings being at McGill University and the University of Montreal. The sections of the Congress have been arranged provisionally as follows: systematics, morphology and anatomy, physiology, behaviour, ecology, geographical distribution, genetics and biometrics, palæontology, arachnids and other land arthropods, agricultural entomology, forest entomology, medical and veterinary entomology, entomology of stored products, biological control, and apiculture. A visit to the Science Service Laboratories, Ottawa, and a number of short excursions will be made during the Congress, following which tours to a number of more distant laboratories and excursions for collecting will be arranged. Further information can be obtained from the secretary of the Congress, J. A. Downes, Division of Entomology, Science Service Building, Ottawa, Ontario.

Third International Congress on High-speed Photography

The third international congress on high-speed photography will be held in the Government Offices, Horse Guards Avenue, London, S.W.1, during September 10–15, and is being sponsored by the Department of Scientific and Industrial Research. The following main topics will be considered: flash sources for high-speed photography and high-speed cinematography; mechanical-optical cameras and drum cameras; high-speed shutters, and scanning

and image dissection methods; and recent applications of these techniques in research, and particularly in the fields of industrial machine analysis, explosive studies (including atomic research), hydrodynamic and aerodynamic research, and medical and biological research. An exhibition of high-speed photographic and cinematographic equipment and associated instrument aids will be held concurrently with the congress, and admission to this exhibition will be free (tickets being obtainable by post from the congress secretariat). The membership fee for the congress is £6 10*s*. Further information can be obtained from the congress secretariat at the Department of Scientific and Industrial Research, Charles House, 5–11 Regent Street, London, S.W.1.

Announcements

Dr. R. F. Gordon, director of the Houghton Poultry Research Station, has been appointed adviser on poultry research to the Agricultural Research Council. The post of adviser is a part-time one, his function being to keep under review research in progress on poultry and to act as technical secretary to the Council's Committee on Poultry Research.

Mr. A. O Cоinneáin, of the Department of Industry and Commerce, Republic of Ireland, has been appointed chairman of the Irish National Committee for Geodesy and Geophysics in succession to Mr. T. O Muireadhaigh.

Mr. Lennart Holm, of the Institute of Systematic Botany of the University of Upsala, has been awarded the 1956–57 Graduate Fellowship of the Mycological Society of America. Mr. Holm, a student of Dr. Nannfeldt, is studying the classification of the Ascoloculares. This is the first time the award has been made to a European student.

The National Physical Laboratory, Teddington, is holding an open day on May 25. Admission is by ticket only, and a limited number of invitations for the afternoon period 1.30–5.30 p.m. are available on application to the Director.

The second Symposium on Condensation Nuclei will be held in Basle and Locarno (Switzerland) during October 1–5, 1956. Those who wish to read papers should write before July 15 to Dr. M. Bider, Astronomisch-Meteorologische Anstalt der Universität, Binningen, Switzerland.

The British Society of Rheology is holding a symposium on "Rheological Research in the Textile Industry" during June 7–8 at the laboratories of the British Rayon Research Association, Manchester. Further information can be obtained from the Secretary, British Society of Rheology, 52 Tavistock Road, Edgware, Middlesex.

The eleventh symposium of the Society for Experimental Biology will be held in the University College of Wales, Aberystwyth, during September 10–14, the subject of the symposium being "The Biological Action of Growth Substances". Non-members of the Society may attend on payment of a registration fee of two guineas. Further information can be obtained from the honorary symposium secretary, Dr. J. F. Sutcliffe, 68 Half Moon Lane, London, S.E.24.

The twenty-first Cold Spring Harbor Symposium on Quantitative Biology will be held during June 4–12, the topic for discussion being "Genetic Mechanisms—Structure and Function". Genetic mechanisms will be considered on the chemical, genic, chromosomal, cellular and developmental levels. The Symposium is open to all on application to the Biological Laboratory, Cold Spring Harbor, New York, whence the full programme and further information can be obtained.

The German Geophysical Association and the German Meteorological Association will be holding a joint meeting in Hamburg during September 25–29. A number of topics of mutual interest will be discussed, and papers are invited (which, together with a summary, should be submitted before June 15). Further information can be obtained from the Deutsche Geophysikalische Gesellschaft, Rothenbaumchaussee 80, Hamburg 13, or the Meteorologische Gesellschaft in Hamburg, Bernhard-Nocht-Strasse 76, Hamburg 4.

A conference on "Heat Treatment Practice", organized by the Metallurgy (General) Division of the British Iron and Steel Research Association, will be held at Ashorne Hill, near Leamington Spa, during June 5–6. There will be three sessions on the following topics: distortion and cracking problems; heating for forging and treatment; and transformations. Application forms and further information can be obtained from the organizer and secretary, Mr. J. R. Powell, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

The title of the quarterly bulletin *Terminological and General Language Review* has been changed to *Reading and Listening Linguistically*, and although the bulletin remains essentially the same in its purpose, namely, the application of the linguistic approach when reading an article so as to pick out the essential features, greater emphasis will be given in the future to the needs of non-academic readers. The bulletin is produced by W. R. Dunlop, 57 Gordon Square, London, W.C.1, from whom further information can be obtained.

The American Physiological Society has given permission to the Johnson Reprint Corporation (125 East 23 Street, New York 10) to reproduce, by the photo-offset process, certain volumes of *Physiological Reviews* and the *American Journal of Physiology*, which are no longer available. The first sets of reprints (*Physiol. Rev.*, 19–29; 1939–49) are expected to be ready before the end of the year at approximately 15 dollars per paper-bound volume. Later, the Corporation hopes to reproduce the following: *Physiol. Rev.*, 31 (1951) and 34 (1954); *Amer. J. Physiol.*, 1–103 (1898–1933) and 114–116, 118–132, 140–145, 147, 152–159 (1935–49).

The Mond Nickel Fellowships Committee is offering up to five travelling fellowships, open to persons of British nationality with degree or similar qualifications, not necessarily in metallurgy, so that they can obtain additional training and experience in industrial establishments at home or abroad (in special circumstances, at a university) in order to make them more suitable for employment in technical and administrative positions in British metallurgical industries. The fellowships will be for one year and will be worth £900–1,200. The awards are seldom made to persons more than thirty-five years of age. Application forms, to be completed by June 1, and further information can be obtained from the Secretary, Mond Nickel Fellowships Committee, 4 Grosvenor Gardens, London, S.W.1.

DIET AND ANÆMIA

THE hundredth meeting of the Nutrition Society, held at the Medical College, London Hospital, on March 10, took the form of a symposium on "Diet and Anæmia", which some 118 members and guests attended. The chair was taken by Sir Stanley Davidson, who in a brief introduction referred to the improvement in the clinical picture which has been effected by better medical education and treatment based on much research, culminating in the discovery of vitamin B_{12}.

The morning session was devoted mainly to the causes of anæmia. The first paper, by Dr. G. R. Wadsworth and Prof. B. S. Platt (London School of Hygiene and Tropical Medicine), was entitled "Zymotic and Other Factors in the Development of Anæmia" and dealt especially with factors affecting the protein economy in its relation to the development of anæmia. About 6 gm. of globin from hæmoglobin is recycled daily, or about a tenth of the estimated total daily protein requirement. If the breakdown products of globin are not returned to the metabolic pool, anæmia may develop if there is deficient protein intake or lack of specific hæmatinic substances such as vitamin B_{12} or folic acid. However, the formation of hæmoglobin takes precedence over that of all other body proteins, even of serum protein; hence deficiency of hæmoglobin may not become evident for a long time, and then will be more readily detected by a fall in the total amount of hæmoglobin in the body rather than by a fall in hæmoglobin concentration in the blood, according to recent findings by Hallgren. Feeding experiments with glycine labelled with nitrogen-15 or with carbon-14 support the view that hæmoglobin may be partly derived from stroma protein and may be synthesized, while the maturing red cell is in circulation, from substances derived from the plasma. Severe anæmia may develop in infections (for example, meningitis) when iron therapy may be of value, in infestations (for example, malaria, hookworm) and following severe burns.

The second paper, by Prof. A. W. Woodruff (London School of Hygiene and Tropical Medicine), dealt with anæmia due to malnutrition in the tropics and mentioned the high maternal mortality-rates in Indian cities. Some nutritional megaloblastic anæmias may be due to deficiency of the Wills factor, which may be distinct from folic acid and vitamin B_{12}. Anæmia due to protein malnutrition may be macronormoblastic, with fibrosis of liver and fatty infiltration, the erythrocytes often being broader and thinner than normal. In the tropics, this type of anæmia can be more serious than megaloblastic and other nutritional anæmias.

The third paper, by Dr. P. B. B. Gatenby, of the Rotunda Hospital, Dublin, dealt with anæmia of pregnancy, which has been investigated there since the beginning of 1953. A special study in 1953 of four hundred cases of severe iron-deficiency anæmia (hæmoglobin less than 9 gm. per 100 ml.) showed half of them to have seldom or never eaten meat or other animal food such as eggs. Iron therapy corrects the anæmia and often prevents relapse to the iron-deficient state before the next pregnancy. In the absence of iron therapy, the incidence of the anæmia increases with the number of pregnancies and with the lowered dietary intakes of iron and vitamin C. In twenty-eight cases of megaloblastic anæmia in which a particular note was taken of the diet, twelve were eating very little meat or eggs, and another eight lacked protein foods, while the remaining eight had an apparently normal diet. Almost all the cases of iron-deficiency anæmia respond to folic acid and some to massive doses of vitamin B_{12}.

In the subsequent discussion, Dr. Lucy Wills expressed the opinion that macronormoblastic anæmia of pregnancy such as was encountered by Prof. Woodruff in Nigeria is an intermediate stage, developing later into megaloblastic anæmia. Prof. Woodruff in his reply suggested that this state of affairs may be due to a deficiency of vitamin B_{12} or of folic acid combined with a protein deficiency.

In the afternoon session, Dr. G. H. Spray (Nuffield Department of Clinical Medicine, Oxford) read a paper on "The Role of Pteroyl Glutamic Acid and Related Compounds in Macrocytic Anæmia". The history of the problem since Wills's work in 1931 was first briefly reviewed. The limited effectiveness of yeast extracts such as 'Marmite' in the treatment of pernicious anæmia may be due to their content of folic acid, although the possible existence of an unidentified 'Wills factor' is not yet entirely ruled out. A normal serum vitamin B_{12} in megaloblastic anæmia is generally taken to indicate a deficiency of folic acid, for which there is no simple test yet available. A hæmopoietic response to folic acid is usually assumed to indicate a disturbance in the metabolism of this factor, which may be due to dietary deficiency (for example, nutritional macrocytic anæmia in India and Africa), defective absorption (in tropical sprue and idiopathic steatorrhœa) or excessive demands, as in pernicious anæmia of pregnancy. In India, Africa and the southern United States, nutritional macrocytic anæmia occurs which is associated with low intakes of fresh fruit and green vegetables and is corrected by oral administration of folic acid. If there is also a very low intake of animal protein, vitamin B_{12} deficiency may be encountered. Anæmia in cases of epilepsy may be due to the use of phenytoin, a possible antagonist to folic acid.

Vilter and his colleagues suggest that folic acid and vitamin B_{12} take part in reactions leading to the synthesis of the nucleoproteins of blood cells from simple precursors. In the absence of vitamin B_{12} there is an excessive demand for folic acid, which keeps the reactions going by 'mass action', and it may eventually become deficient. Large doses of folic acid increase blood formation, using up the remaining small stores of vitamin B_{12} and causing exacerbation of the nervous degeneration. In patients with pernicious anæmia, there may be eventually hæmatological relapse. This useful working hypothesis does not explain completely the role of folic acid in blood formation, its utilization from the diet, its storage and excretion, and the question as to the utilization of folic acid synthesized by intestinal bacteria still remains unanswered.

The second paper in the afternoon session was by Dr. J. R. Evans (Nuffield Department of Clinical Medicine, Oxford) and dealt with the absorption of vitamin B_{12} in the megaloblastic anæmias. Vitamin B_{12} labelled with cobalt-60 was used, and the radioactivity of the fæces was measured after an oral dose of 0·5 μgm., the assumption being made that all

radioactivity not recovered in the fæces had been absorbed. In forty-four observations on thirty-five control subjects, the radioactivity in the fæces ranged from 9 to 47 per cent and averaged $27 \cdot 3 \pm 1 \cdot 6$ per cent of that present in the oral dose. In twenty-four pernicious anæmia patients, the corresponding average percentage was $92 \cdot 3 \pm 1 \cdot 3$. When these patients were given intrinsic factor, most of the results were within the limits observed in normal subjects. Achylia and atrophy of the gastric mucosa supported these findings in each of nineteen of the patients who were studied. Sterilization of the bowel with chlortetracycline did not increase the uptake of labelled vitamin B_{12} in a patient with untreated pernicious anæmia. Studies on megaloblastic anæmia following gastric surgery showed that, after total gastrectomy, little or no labelled vitamin B_{12} is absorbed unless intrinsic factor is given with it. In five patients with partial gastrectomy, failure of absorption was corrected by intrinsic factor, while in another nine patients in whom no megaloblastic anæmia developed after removal of the distal half of the stomach, there was no permanent impairment of vitamin B_{12} absorption. In seven patients with idiopathic steatorrhœa and megaloblastic anæmia, absorption was normal in one young patient, slightly impaired in another and negligible in the remaining five. Intrinsic factor seldom caused improvement, even when given in very large doses. In another four patients with idiopathic steatorrhœa, but no megaloblastic anæmia, absorption was normal in three, and only slightly reduced in the fourth. Absorption was unaffected in megaloblastic anæmia of pregnancy or the puerperium and in megaloblastic anæmia associated with epilepsy.

The final paper, by Dr. F. Wokes (Ovaltine Research Laboratories, King's Langley), described anæmia associated with dietary deficiency of vitamin B_{12} encountered in a group of about a hundred and fifty persons termed 'vegans' who consume no animal food whatever. There was no megaloblastic or macrocytic anæmia, but in rather less than half the subjects there were low serum B_{12} levels (less than 100 μμgm./ml.) accompanied by neurological manifestations ranging from slight paræsthesia to subacute combined degeneration of the cord. The wide variation in response was probably not due to variations in dietary intake of the vitamin, which was not found in significant amounts in the foods consumed by the 'vegans'. It was thought to be more likely to be caused by differences in the degree of intestinal synthesis of the vitamin.

Study of the 'vegan' diet showed its vitamin content to be satisfactory, apart from B_{12} and possibly also D. The average protein intake was rather low (9–11 per cent on the calorie basis), and the large amounts of pulses consumed tended to lead to a deficiency of methionine, which would be aggravated by the deficiency of vitamin B_{12}. This, together with the unusually high intakes of folic acid from green vegetables, may have been responsible for the neurological manifestations.

The part played by vitamin B_{12} in the *de novo* synthesis of labile methyl groups to convert homocysteine to methionine, and also in the reduction of disulphide to sulphydryl groups, has led to a study in 'vegans' and non-'vegans' of the metabolism of thiocyanate, the sulphur-containing detoxification product of cyanide, in the metabolism of which vitamin B_{12} in the form of hydroxo- or aquocobalamin appears to be implicated. A sulphur transfer cycle was described for synthesis of essential sulphur-containing metabolites which might include the methionine deficient in 'vegan' diets. Lack of vitamin B_{12} might also, by inhibition of a sulphydryl system, lead to abnormal metabolism of tryptophan and tyrosine, with accumulation of toxic products, which might be responsible for the neurological manifestations.

In the subsequent discussion, Dr. C. C. Ungley described scotomata occurring in one of the 'vegans', which were cured by prolonged administration of vitamin B_{12}.

VEGETABLE TANNINS

SYMPOSIUM IN CAMBRIDGE

THE Society of Leather Trades' Chemists held a symposium on "Vegetable Tannins" during April 12–13 in the Chemistry Department, University of Cambridge, at which more than a hundred members and guests participated.

After the symposium had been opened by the president of the Society, Dr. R. G. Mitton (British Leather Manufacturers' Research Association), the chairman, Prof. R. D. Haworth (Chemistry Department, University of Sheffield), briefly referred to Emil Fischer's outstanding contribution to the chemistry of the gallotannins and mentioned how the early optimistic attempts of the 1920's to bring order to the untidy field of tannin chemistry was not realized. The reason for this is that those physical methods, which are now used for the isolation of single substances, were unknown. As a result of recent work, much of which, said Prof. Haworth, has been carried out by those present at the symposium, order and interest have been restored. Considerable academic and technical research is now in progress, and we have learned much concerning the units from which the complex tannins are composed.

In an introductory paper, on the scope of vegetable tannin chemistry, Dr. T. White (Forestal Central Laboratories) treated historically the chemistry of the tannin and related polyphenol constituents of the principal vegetable tannin extracts. He dealt with the previously proposed classification of tannin extracts, defined a tannin (as opposed to a polyphenol) and directed attention to tannin action. New work on the degradation of the major constituent of commercial gallotannin was outlined. The preliminary results can be interpreted in terms of a trisaccharide formula which is reminiscent of the tetrasaccharide formula proposed this year for sumach gallotannin by Grassmann and co-workers. Dr. White stressed that the condensed tannins cannot now be considered as a single class of compound. His paper included a review of the physical chemistry of gross tannin extracts, and a provocative account of the physiological function of tannins in the intact plant, notably as inactivating agents for vector-transmitted virus proteins.

Mr. H. G. C. King (also of the Forestal Central Laboratories) and Dr. White then gave a paper on quantitative determination of specific nuclei and components of vegetable tannin extracts. In the same way that paper chromatograms may be used for the separation of tannin constituents, they may also form the basis for the estimation of these substances, when used in conjunction with specific

reagents and reflectance spectrophotometry. Examples of catechol, monosaccharide, phloroglucinol, pyrogallol and resorcinol estimations were included.

In a paper on gallotannins and ellagitannins, Prof. D. Burton and Dr. H. E. Nursten (University of Leeds) outlined the work of the Leather Industries Department at Leeds under the successive administration of Profs. Atkin and Burton, both of whom had applied electrometric titration methods to gross tannin extracts and their dialysates, plant acids and their salts being found in the dialysate. By means of cation-exchangers, the salt content was estimated before and after dialysis. Application of these methods to the types of extract under consideration has afforded analyses of use to the industry.

Prof. O. Th. Schmidt (Chemical Institute of the University of Heidelberg) then gave a paper on the constitution of chebulinic acid. A Diels–Alder adduct of dimethyl fumarate and 1-acetoxybutadiene was formed, and the configuration of the separate racemates was unambiguously determined. Treatment of the *trans-trans*-tetrahydrophthalic acid dimethyl ester with ozone and hydrogen peroxide successively gave a cleavage product, the antipodes of which were resolved with brucine. One antipode was identical with the butanol tetracarboxylic acid lactone, derived from chebulic acid. Hence, both these substances have the racemoido-racemoido-configuration. Addition of the elements of water to chebulinic acid gave *neo*chebulinic acid, which afforded chebulic acid and a trigalloylglucose on hydrolysis. The latter proved to be identical with 1β : 3 : 6-trigalloyl-D-glucose, which was synthesized from triacetyl-L-glucosan. Application of the new results suggests a constitutional formula for chebulinic acid.

In his exploratory study of the polyphenols and polyphenolase of tobacco, Mr. W. W. Reid (Research Department, Carreras, Ltd.) fractionated tobacco extracts by lead acetate precipitation and solvent extraction. These fractions were further subdivided as band chromatograms on thick paper, and homogeneous fractions were estimated by modern scanning techniques. Cellulose columns were also employed, and the enzymic oxidation of the resulting polyphenols by tobacco polyphenolase was studied.

In a contribution on paper chromatography as an aid to the elucidation of the structure of polyphenols occurring in tea, Dr. E. A. H. Roberts (Indian Tea Association Chemical Laboratory) exemplified the technique by the separation of (+)- and (−)-catechin and of *cis*- and *trans*-cinnamic acids. Accordingly, (+)-catechin, (−)-*epi*catechin, (+)-gallocatechin, (−)-*epi*gallocatechin, and *cis*- and *trans*-chlorogenic and *neo*chlorogenic acids were identified, theogallin was shown to be a galloyl ester of quinic acid, and chromatographic evidence for the occurrence of both *p*-coumarylquinic acids and myricetin glycosides was advaneed. The possibility of the production of benztropolones in tea fermentation was tentatively considered.

Dr. D. E. Hathway (British Leather Manufacturers' Research Association), in a communication on some approaches to aromatic biosynthesis leading to polyphenols and tannins, described the separation and identification of ellagic acid in plant extracts, and the separation of a plant acid fraction from myrobalans by means of ion-exchange chromatography. Related *cyclo*hexanecarboxylic acids were identified by paper chromatography, and they were separated by extended ion-exchange methods. The chromatogram of the polyphenols and tannins of myrobalans was elucidated. On account of Davis's microbial studies, and the presence of *cyclo*hexanecarboxylic acids concomitant with simple polyphenols and tannins in myrobalans, Hathway suggested that they may also be precursors of aromatic amino-acids, polyphenols and tannins in the plant. The occurrence of *cyclo*hexanecarboxylic acids in other plants was mentioned, and the question of the ubiquity of shikimic acid was raised. The use of radioactive tracers in lignin biosynthesis was cited, and the emergence of C_7—C_9 plant compounds, including gallic acid, from the *cyclo*hexanecarboxylic acid sequence was discussed.

On the second day the conference was continued under the chairmanship of Dr. F. E. King (Research Department, British Celanese, Ltd.). In their review of the leuco-anthocyanins, Drs. T. Swain and E. C. Bate-Smith (Low Temperature Research Station, Cambridge) have divided these substances into a category requiring oxygen for the transformation into anthocyanidin, and a category which does not require it. Little is known of the chemical structure of many of these substances. King and Bottomley (1953) isolated a leuco-anthocyanin, however, which they proved had a flavan-3 : 4-diol structure (7 : 8 : 3′ : 4′-tetrahydroxyflavan-3 : 4-diol), the tetramethyl ether of which was afterwards synthesized by King and Clark-Lewis. Meanwhile, Swain had synthesized the 5 : 7 : 3′ : 4′-isomer by hydride reduction of taxifolin. This new leuco-anthocyanin does not occur in Nature, it being different from that in apple and cacao. Two decades earlier, Robinson and co-workers provided considerable evidence for the structure of cyanomaclurin and peltogynol, neither of which belongs to the flavan-3 : 4-diol type. Leuco-anthocyanins are sometimes mobile on paper chromatograms, and this is a behaviour consistent with comparatively simple structures. A stationary class may be due to chemically unidentified polymers.

Mr. W. E. Hillis (Division of Forest Products, Commonwealth Scientific and Industrial Research Organization, Australia), in a communication on leuco-anthocyanins as the possible precursors of tannins, showed that the leuco-anthocyanin content of vegetable tannin materials follows the intensity of red colour imparted to leather. In regions of active growth, such as the leaf tips and cambium during spring, there is a relatively high accumulation of leuco-anthocyanins. Mr. Hillis presented evidence that in eucalypts these substances originate in the leaves and move down the phloem across the cambium into the wood. Leuco-anthocyanins may be transformed into 'tannins' at the sapwood–heartwood boundary.

Dr. W. Mayer (Chemical Institute of the University of Heidelberg), in a paper on catechins from the bark of oak and sweet chestnut, described the isolation of (+)-catechin and (+)-gallocatechin from these plant tissues. (+)-Gallocatechin proved identical with Oshima's casuarin. Reduction of the pentamethyl ether with sodium and alcohol invoked desmethoxylation, and the resulting diphenylpropane was also obtained from pentamethyl (−)-*epi*gallocatechin and was synthesized via the chalcone. The similar desmethoxylation of O-trimethylpyrogallol was encountered by Kostanecki.

In a communication on the occurrence and properties of dihydroflavonols (4-oxocatechins), Dr. J. E. Gowan, Mrs. E. M. Philbin and Prof. T. S. Wheeler (Chemistry Department, University College, Dublin)

reviewed the occurrence of the eight dihydroflavonols in the plant kingdom: dihydro-kæmpferol and -myricetin occur most frequently. Dihydroflavonols have been synthesized by six methods: oxidation of 2′-hydroxychalcones and flavanones; bromination of flavanone, followed by nucleophilic replacement of halogen; ring-closure of 2′-hydroxy-α-methoxychalcones; treatment of 2′-acetoxychalcone dibromides with silver acetate or alkali; dithionite reduction of flavonols; and reaction of aromatic aldehydes with 2-hydroxyphenacyl chlorides. Under the influence of alkali, dihydroflavonol disproportionates into the flavonol and flavanone, or affords the corresponding 2-benzyl-2-hydroxycoumaran-3-one.

Dr. W. B. Whalley (Organic Chemistry Department, University of Liverpool), discussing the stereochemistry of the chromans and related compounds, dealt with a stimulating application of conformational analysis. In common with King, Dr. Whalley agrees with the assignment to catechin and *epi*catechin of *trans*- and *cis*-structures, respectively, but he produced evidence in favour of fresh conformations with 3(α)-hydroxyl groups for both substances. Conformational analysis has been extended to the 3-hydroxyflavanones, 2-hydroxy*iso*flavanones and flavan-3 : 4-diols, and it is evident that Dr. Whalley will elucidate the conformation of the complicated O-ring heterocyclics by application of stereo-specific reactions.

The Society will publish the symposium lectures and discussions in book form, and this should interest all those whose work brings them into contact with polyphenols, tannins and vegetable tannin materials.

D. E. Hathway

EAST AFRICAN INDUSTRIAL RESEARCH ORGANIZATION

REPORT FOR 1954–55

THE East African Industrial Research Organization, which incorporates the East African Industrial Research Board, came into existence on April 1, 1955, and its first annual report* is a progress report covering the period January 1, 1954–June 30, 1955. The new Organization absorbs the staff of the previous Board, and provision is made for a 50 per cent increase during the next two years. The British Government is contributing, from Colonial Development and Welfare Funds, 75 per cent of the capital expenditure for offices and laboratories and housing, and half the recurrent expenditure during the next two years. The Organization will be responsible to a board, on which the East African Government and the East African High Commission are represented.

The present report summarizes the work in the production of hecogenin from sisal waste, the plant for which has operated successfully since it was officially opened in June 1954. A preliminary report has been issued on the investigation of coffee processing which indicates that there are three stages in drying fermented coffee and that it is desirable to dry-wash the fermented coffee initially as quickly as possible, without using too high a temperature. When the coffee is dry enough to be safe from deterioration, the remaining process may be a slower removal of moisture in a conditioning bin. Work with dual-fuel engines, using oil and indigenous wood, has shown that producer gas can replace diesel oil in a diesel engine and is utilized as efficiently thermally as the oil. Satisfactory ignition of the gas–air mixture can be achieved with a low proportion of the full-load consumption of oil; at least 70 per cent of the full-load rating of a coupled diesel engine and alternator can be carried on gas, while the governor retains full control of speed, and existing engines can be modified economically on the site.

Chemical engineering research has been concerned with the utilization of natural steam, the production of salt and lime burning; in ceramics a refractory grog has been produced by calcining fine kyanite, bonded into pellets with molasses in a rotary kiln, and also a porous grog by grinding raw kyanite with charcoal, pelleting with molasses and calcining in the laboratory at 1650° C. Other work has been concerned with the production of phosphatic fertilizers and the pelletizing of cetyl alcohol for use in retarding the evaporation of water from dams. For this latter purpose, following work by A. F. C. Cole, who died during the period, apparatus has been devised by which an output of 20 lb. a day has been achieved. The apparatus is described and illustrated in the report.

* East African High Commission. East African Industrial Research Organization: Annual Report 1954–55. Pp. ii+17. (Nairobi: East African Industrial Research Organization, 1955.)

CURRENTS THROUGH THE STRAITS OF DOVER

NEARLY a hundred and twenty-five years ago Faraday predicted that electrical potential differences would be set up in sea water, a conducting fluid, by its motion in the Earth's magnetic field. His predictions were verified by measurement of voltages induced on submarine cables. During recent years, oceanographers have begun to use measurements of the voltage differences in sea water as a useful method of studying water transport. In a recent paper (*Phil. Trans. Roy. Soc.*, A, **248**, 953; 1956) K. F. Bowden has demonstrated the value of the method in his study of the flow through the Straits of Dover. He has taken as his raw material fifteen months of continuous observations of the voltage fluctuations induced on a cable crossing the Straits of Dover, together with four months of similar observations on a cable crossing the south-western portion of the North Sea. Regular voltage fluctuations, about one volt in amplitude, produced by the tidal currents are a dominant feature of his records. These fluctuations, while serving a useful purpose for calibrating the voltage in terms of the mean flow through the Straits, have to be eliminated to study the more interesting residual currents. The calibration, which depends on the conductivity of the sea bed as well as the sea water, is done empirically. Shorter-period fluctuations produced by magnetic disturbances are eliminated by filters in the measuring equipment and by smoothing of the graphical records.

Prof. Bowden shows that the residual currents, which sometimes run with speeds as high as one and a half knots in either direction, are highly correlated with the local winds and the slope of the sea surface along the Straits. The correlation is also high with the wind system over the southern part of the North Sea and the English Channel, indicating that the surface slope along the Straits is largely a consequence

of the regional wind system, though influenced as well by other factors. Prof. Bowden's measurements enabled him to make estimates of the coefficients of wind stress and of bottom friction. These estimates, though somewhat high, agree in magnitude with other independent estimates and strengthen the probability that further development of the dynamics of the air–sea interactions can be made through similar studies. Such studies are at present being made of the Gulf Stream through the Florida Straits and of currents in the Cook Straits of New Zealand, and others are being planned.

Prof. Bowden was perhaps fortunate in studying a region that has been extensively surveyed in the past and he had access to detailed meteorological and tidal information in carrying out his analysis. The method he has employed has emerged as a powerful supplement to the usual techniques of oceanographic survey and is, at present, the only practical way in which large-scale currents can be continuously monitored.

N. P. Fofonoff

AMPHITHALLISM IN FUNGI

By M. EILEEN KENNEDY and Prof. J. H. BURNETT

University of St. Andrews

IT has generally been found that the mating systems of fungi are very constant features and that if, for example, a species is heterothallic, it regularly produces spores which are homocaryotic in respect of mating type. However, exceptional fungi are known which produce spores both homocaryotic and heterocaryotic for mating-type factors on the same fruit body. Lange[1] introduced the term 'amphithallism' to describe this condition in species of *Coprinus*.

Recently we have investigated an amphithallic condition in some strains of bipolar gasteromycetes of the *Nidularia denudata* 'complex', and it is now evident that confusion has arisen in the application of Lange's term. This is because, first, different mechanisms give rise to the condition and, secondly, because the term has been applied to quite different phenomena.

At least four mechanisms are known which can result in the production of spores both homocaryotic and heterocaryotic for mating-type by a single fruit body, namely:

(1) In certain Basidiomycetes with four-spored basidia, an additional mitosis after meiosis results in the occurrence of eight-nucleate basidia. Two nuclei migrate into each basidiospore and they may carry the same or different mating-type factors, that is, the basidiospores will be homocaryotic or heterocaryotic for mating type, respectively. Unequivocal cytological and breeding evidence for this situation has been obtained in strains of *Nidularia denudata* by one of us (M. E. K.), details of which will be published elsewhere. Circumstantial evidence for a similar mechanism is available in *Omphalia flavida*[2], *Coprinus plagioporus* and *C. subpurpureus*[1].

(2) In certain Basidiomycetes with two-spored basidia, meiosis occurs in the basidium and two nuclei migrate into each basidiospore. Single basidiospore isolates usually germinate to give a mycelium bearing clamp-connexions. Exceptions have been recorded in *Coprinus sassii* (= *C. ephemerus* f. *bisporus*)[1,2], *Galera tenera* f. *bispora*[3], *Aleurodiscus canadensis*[4] and *Mycena rubromarginata*[5]. In these fungi some single-spore isolates failed to form clamp connexions, and appropriate matings demonstrated that such isolates, of the same species, carried complementary mating-type factors, that is, the basidiospores from which these isolates originated were homocaryotic for mating-type factors. Recently, Terra[6] has demonstrated that this interpretation is correct in *Stropharia umbonatescens* and has also demonstrated, by mechanical separation, the heterocaryotic nature in respect of mating type of the rest of the basidiospore isolates. It is not known at present why basidiospores of such fungi are normally heterocaryotic in this respect, although an association between nuclei of complementary mating type during migration into the spore has been suggested[3].

Basidiomycetes have been described which, in addition to two- and four-spored basidia, possess a variable but usually small number of basidia which bear three, five or more spores. It has been suggested[7,8] that unequal distribution of the four nuclei derived from meiosis to these basidiospores would result in spores homo- and hetero-caryotic in respect of mating type. No acceptable experimental evidence has been presented, as yet, in support of this claim.

(3) Most Ascomycetes regularly produce eight, initially uninucleate, ascospores; but occasionally some of them are replaced by 'giant' binucleate spores, some of which may be heterocaryotic for mating-type factors, for example, *Neurospora crassa*[9]. In other Ascomycetes four, initially binucleate, spores, each heterocaryotic for mating type, are formed regularly in each ascus. But in these fungi uninucleate ascospores, which are necessarily homocaryotic for mating-type, are formed exceptionally with variable frequencies, for example, in *Neurospora tetrasperma*[10], *Podospora anserina*[11]. The mechanism common to both these exceptional conditions is the irregular delimitation of the cytoplasm at spore formation, but the causes of such irregularities have not been fully investigated. A similar kind of irregularity is presumably responsible for the occasional heterocaryotic meiospores produced by the Phycomycete, *Phycomyces blakesleeanus*[12].

(4) Heterocaryosis for mating-type factors in the ascospores of the four-spored Ascomycetes such as *N. tetrasperma* is a consequence, not only of the mode of spore delimitation, but also of the orientation of the spindles during nuclear divisions in the ascus and the time of segregation of the mating-type factors during meiosis[13]. However, the occurrence of asci with initially binucleate ascospores, which are homocaryotic for mating type, has been reported[14,15]. In *N. tetrasperma* it has been suggested[16] that this may come about as a result of irregularities in spindle orientation; but a different mechanism, the intervention of crossing-over between the mating-type locus and the centromere, which alters the spatial segregation pattern of the mating-type factors in the ascus, has been described[15] for *P. anserina*. Completely acceptable cytological and genetical evidence for these hypotheses is not available.

Amphithallism can be applied to the results of the four types of behaviour described, since they all lead to the production of spores, homocaryotic and heterocaryotic for mating type, by a single fruit body. But amphithallism will affect the mating systems of different fungi in quite different ways. For example, in an outbreeding form such as *Coprinus subpurpureus*, amphithallism restricts the degree of potential outbreeding, but in an inbreeding fungus

such as *Neurospora tetrasperma* it will introduce a measure of potential outbreeding.

The other point to which we direct attention is the suggested application by Olive[17] of amphithallism to an altogether different mode of behaviour. He has shown that single-ascospore isolates of *Sordaria fimicola* will produce fertile perithecia in culture, but if such isolates are grown in pairs, fertile perithecia are formed preferentially in the zone of contact between them. He suggests that the definition of amphithallism be extended to include this condition, which he describes as the tendency in a homothallic organism towards heterothallism. Such usage seems to us to be a misapplication of the term. Olive's situation is reminiscent of that described as "relative heterothallism" in *Aspergillus nidulans*[18], and the mechanisms responsible for these phenomena are not yet understood. But the causes and consequences of these phenomena must be entirely different from those responsible for the amphithallic condition as described earlier. [Feb. 4

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EFFECT OF SOLUTE CONCENTRATION IN THE IRRADIATION OF AQUEOUS SOLUTIONS BY IONIZING RADIATIONS

By Drs. G. R. A. JOHNSON, G. SCHOLES and J. WEISS

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DURING recent years, considerable attention has been paid to the chemical action of ionizing radiations on aqueous solutions, largely due to the possible significance from a radiobiological point of view. Most of the work hitherto reported in the literature has been concerned with very dilute solutions; but it is clear that, with regard to the elucidation of the reaction mechanisms as well as to the biological aspects, the behaviour of more concentrated solutions and altogether a much wider range of concentrations should be considered.

For dilute aqueous solutions, it is generally accepted that the chemical action of ionizing radiations on the solute is an indirect one, that is, via the free radicals (OH and H) produced from the water[1]. On this basis, the chemical yield should be independent of concentration of solute over a fairly wide range, provided that sufficient solute is present to utilize all the available radicals produced from the solvent. It has been usually supposed that this, in fact, holds in all cases. With organic solutes, however, no clear experimental evidence has been presented to prove such a generalization.

In the course of some recent work on the mechanism of the chemical action of X-rays on several organic compounds in dilute aqueous solutions, detailed studies have been made of the effects of concentration of solute on the yields of radiation products. It has been found that in none of the cases so far investigated does the yield actually become independent of the solute concentration up to concentrations of about 1 *M*. Fig. 1 shows the dependence of the initial yields of acetaldehyde from aqueous ethanol solutions[2] and of pyruvic acid from lactic acid solutions, as a function of solute concentration; irradiations were carried out in the presence of dissolved oxygen, at room temperature. These experiments show that within the range 10^{-5}–1·0 *M*, the yield of the product never becomes independent of the solute concentration. The relative increase in oxidation yield is greatest in the lower region, that is, up to 10^{-3} *M*. However, at higher concentrations the yield still continues to increase and, in these systems, can eventually attain values which are considerably greater than the maximum that could arise from the yield of hydroxyl radicals resulting from the decomposition of water by the radiation, normally supposed to correspond to $G \simeq 3{\cdot}0$–$3{\cdot}5$ (molecules/100 eV.). Over the concentration-range considered here, 'direct effects', that is, changes due to the absorption of the radiation energy by the solute, even at the highest concentration employed, cannot amount to more than about 10 per cent.

In several other reactions induced by radiation in aqueous systems, for example, the formation of

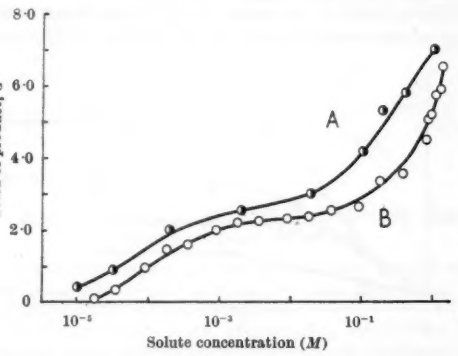

Fig. 1. Irradiation of aqueous solutions with X-rays (200 kV.) in the presence of oxygen (1 atm.). pH = 1·2. Dose-rate = 2×10^{17} eV./ml./min. [$G(Fe^{3+}) = 15{\cdot}5$] Dependence of the initial yields on the solute concentration. Curve *A*: pyruvic acid from lactic acid solutions; curve *B*: acetaldehyde from ethanol solutions

ammonia from α-alanine[3], of inorganic phosphate from the α- and β-glycerophosphates (Taylor, Scholes and Weiss, unpublished results) and from ethyl phosphate (Wheeler, Scholes and Weiss, unpublished results) and of acetaldehyde from ethylamine[2], it has been found that, over the range of solute concentrations studied, the yield of the product does not attain a constant value. All these experiments were carried out with X-rays (200 kV.) in the presence of dissolved oxygen. Some preliminary experiments, using cobalt-60 γ-rays, which have been carried out with the ethanol and lactic acid systems, have shown that the dependence of the yield on solute concentration is essentially similar to that observed with X-rays. Although in a given system the *p*H of the solution is sometimes a determining factor for the yield of the products, it does not, in general, appear to influence the overall dependence of yield on concentration.

A few cases have previously been reported in which the effects of solute concentration have been studied. It has been emphasized that there is a marked dependence on concentration of the yield of ammonia from glycine[4]; reference may also be made to the irradiation, with γ-rays, of solutions of formic acid[5] and of ethanol[6], where somewhat similar effects have been noted. It should be pointed out that in the early experiments of Fricke *et al.*[7], Kinsey[8], and Stenström and Lohmann[9], the yield of the product did not become independent of concentration over the range investigated.

Hydrogen peroxide is produced in all these solutions irradiated in the presence of oxygen, and the yield of this has been determined, in several systems, as a function of solute concentration. Some of the results obtained are recorded in Fig. 2. The rather striking fact emerges that the initial yield of hydrogen peroxide ($G(H_2O_2)$), in contrast to that of the organic product, is, in these cases, more or less independent of solute concentration over a relatively wide range; the value of $G(H_2O_2)$, however, varies according to the solute and must, therefore, be related to the mechanism of the oxidation processes involved. It is of some interest to note that in all the cases examined (cf. Fig. 2) the yield of hydrogen peroxide becomes practically independent of solute concentration when the latter exceeds about 10^{-3} *M*, that is, the concentration at which the rate of increase of the yield of the organic product changes markedly.

It is difficult to reconcile these observations with some of the simple views on the action of ionizing radiations in aqueous systems. The observed increase in the yield of organic product with increasing concentration of solute could possibly be explained, for example, by (*a*) reactions of the solute with hydrogen atoms when the concentration of the former is sufficiently high to compete with oxygen in the reaction $H + O_2 \rightarrow HO_2$; (*b*) electronic excitation of the solute molecules by the slow electrons produced by the ionizing radiations[10]; (*c*) further reactions of the solute with those active species (for example, free radicals) which may only become available at higher concentrations of solute. (It should be borne in mind that we have no independent knowledge of the extent of the primary decomposition of the water into free radicals, and there could be, in the more dilute solutions, an appreciable amount of recombination or deactivation of the active species.)

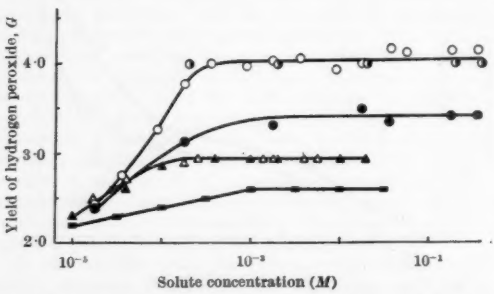

Fig. 2. Dependence of the initial yields of hydrogen peroxide on the solute concentration in different aqueous solutions irradiated with X-rays (200 kV.) in the presence of oxygen (1 atm.). Dose-rate = 2×10^{17} eV./ml./min. [$G(Fe^{3+}) = 15{\cdot}5$]
○, Ethanol, *p*H = 1·2; ●, ethanol, *p*H = 5·5; ◑, lactic acid, *p*H = 1·2; ▲, α-glycerophosphate, *p*H = 1·2; △, β-glycerophosphate, *p*H = 1·2; ■, monoethyl phosphate, *p*H = 1·5

The dependence of the overall yield on the concentration of the solute ([*c*]) should be, in each of the cases discussed above, given to a first approximation, by an expression of the type:

$$\text{Yield} \simeq \frac{k_1[c]}{k_2 + k_3[c]}$$

where, in general, k_1, k_2, k_3 are functions of the various parameters such as the initial local concentration of the free radicals in the tracks of the ionizing particles, the concentration of molecular oxygen, etc.; the experimental results (cf. Fig. 1) do, in fact, appear to conform with such an expression. (It should be pointed out also that the nature of the yield-concentration plots does not support the occurrence of chain reactions in the systems under consideration.)

It is clear, from the above remarks, that in studies of the effects of ionizing radiations on organic compounds in aqueous systems, much more attention should be paid to the influence of concentration of solute; selection of any arbitrary concentration for the elucidation of the reaction mechanism may lead to erroneous conclusions. In particular, caution must be exercised in deriving values for the yields of primary radicals from the results obtained in any system at any one concentration of solute. Nevertheless, the study of aqueous systems of organic compounds, rather than of some simple inorganic systems, appears to be capable of yielding more complete information about the various primary processes following absorption of radiation, since it is possible that some important features may not be revealed in simple inorganic systems where the same product is often formed via different routes.

Some of the experiments reported here were carried out by Mrs. Freda Hope, to whom our thanks are due. We wish to acknowledge, with thanks, the financial assistance of the North of England Council of the British Empire Cancer Campaign and of the Rockefeller Foundation. [Feb. 27

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Structure of Azulene

PREVIOUS work on the crystal structure of azulene[1] has shown that the apparent space group is $P2_1/a$ (C^5_{2h}) with two molecules in the unit cell. This implies a centrosymmetric molecule, which is in conflict with the chemical evidence. The two most likely explanations of this discrepancy are: (*a*) that the implied centre of symmetry is only statistically true, and is due to rotating molecules or a disordered structure; or (*b*) that the absent spectra leading to the deduction of the space group $P2_1/a$ are accidental, and that the true space group is really of lower symmetry. Günthard[2] has discussed these possibilities, and in recent work[3] has shown that a comparison of the entropies of azulene and naphthalene (which has similar lattice dimensions) appears to confirm the presence of some disorder in the azulene crystal.

We have now made a further examination of the crystal structure of azulene and have obtained the cell dimensions $a = 7{\cdot}91 \pm 0{\cdot}02$, $b = 6{\cdot}00 \pm 0{\cdot}02$, $c = 7{\cdot}84 \pm 0{\cdot}02$ A., $\beta = 101°\ 30'$. This unit cell contains two molecules of $C_{10}H_8$ and the $(h0l)$ reflexions are absent when h is odd. We have looked for the $(0k0)$ spectra carefully up to the seventh order, giving long exposures on oscillation photographs, but have only been able to find (020) with F about 15·5 and (060) with F about 1·7. What appeared to be a weak (010) was observed with copper radiation, but this is probably spurious and could not be repeated with iron radiation.

So far our work is in good agreement with previous results and suggests the space group $P2_1/a$, although only two $(0k0)$ reflexions can be recorded. To obtain further evidence we have applied the statistical tests of Wilson[4] and Howells[5] to the $(h0l)$ spectra, and the results indicate quite strongly that the projection of the structure on (010) is non-centrosymmetrical. If this conclusion is accepted, it means that the $(0k0)$ absences are accidental and that the space group is probably Pa (C^2_s) with two asymmetric molecules in the unit cell.

Proceeding on this assumption, a trial structure based on the chemical formula was postulated and refined by the method of difference syntheses. Good agreements were soon obtained for all the $(h0l)$ spectra, and an electron-density projection of the structure on (010) is shown in Fig. 1. At this stage the average discrepancy between observed and calculated structure factors in the $(h0l)$ zone is 11 per cent. The other zones also give substantial agreements and are being further refined.

The positions of the molecules in the unit cell are similar to those of the naphthalene structure[6], although the azulene molecules have a rather different orientation. Their position with respect to the glide plane is such as to create an almost exact halving of the $(0k0)$ spectra; but this halving is, of course, accidental in the sense that it is not necessarily imposed by the symmetry elements of the space group. From Fig. 1 it is seen that the molecular plane is steeply inclined to (010), as in the corresponding naphthalene structure, and this prevents clear resolution of all the atoms. Nevertheless, the form

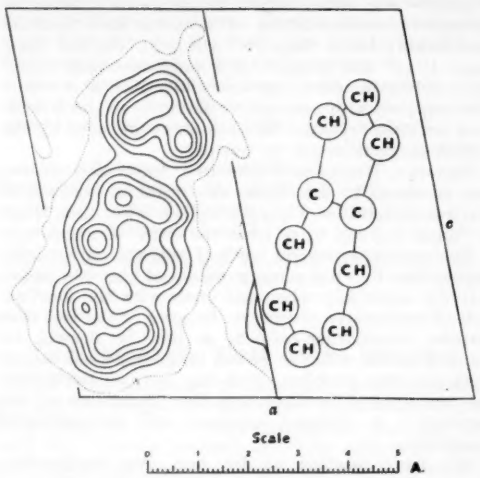

Fig. 1. Projection of the azulene structure on (010)

of the molecule, consisting of a fused five- and seven-membered ring system, can be clearly seen. Although some disorder may be present in the structure, it does not seem to be enough to prevent a full determination of the molecular structure by the X-ray method.

The peak values of the electron density are seen to vary in an interesting manner on the different atoms; but neither these variations nor the variations of bond-length which can be obtained after allowing for the orientation are significant at the present stage of refinement. As the structure is non-centrosymmetric, it is expected that this refinement process will have to be carried quite far, probably with the use of full three-dimensional data, before really significant and chemically interesting results are obtained. This work is now proceeding.

We are indebted to Prof. Wilson Baker and to Dr. E. Clar for supplies of pure azulene.

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Radioactivity of Iron Meteorites by the Photographic Method

WE wish to present the preliminary results of a study of the α-radioactivity of iron meteorites by the method of nuclear emulsions.

The important work of Paneth's group[1] on the helium ages of iron meteorites shows uranium and thorium contents of $0{\cdot}1\text{–}1 \times 10^{-6}$ gm./gm. Davis's radium determinations on seven iron meteorites gave uranium equivalents of the same order of magnitude[2].

The meaning of the helium ages has been discussed by Urey[3,4]. He states that on thermodynamical

grounds[3,5] one would expect in the metallic phase of meteorites concentrations of uranium and thorium considerably lower than 10^{-9} gm./gm. On the other hand, Urey[3] and Singer[6] have suggested that radiogenic helium could be preferentially lost as a result of a localization of radioactive elements in the boundaries between crystals. In such an event, ages by the helium method would be too low.

Recently, Reed and Turkevitch[7] have used activation methods to determine the uranium content of two iron meteorites. Their results are lower than those of Paneth's group by at least one order of magnitude.

The nuclear emulsion method appears particularly appropriate for such measurements of very low radioactivity, especially when one deals with the localization of radioactive elements. In spite of the fact that definite conclusions cannot, as yet, be drawn, we think it worth while to give a progress report on our work on this problem, pointing out, in particular, the technical difficulties and the limitations of the method. A detailed account will be published elsewhere.

We have studied so far two iron meteorites: Toluca (Hamburg) and Carbo. Uranium and thorium contents have been determined by Dalton *et al.* on other samples of these octahedrites[8]. We have counted and localized two thousand α-particle tracks, on an area of 32 cm.² of plates (Ilford *C*2, exposure time 140 days). Range-distribution analysis indicates that more than 85 per cent of the α-particles counted must result from surface contamination of the samples by polonium, in spite of many precautions to prevent it. However, this contamination corresponds to no more than 100 polonium atoms (10^{-14} curie) per sq. cm.

To reduce as much as possible the effect of the surface contamination in determining the uranium and thorium content, only tracks with a residual range in the emulsion of less than 15 microns were taken into account. This being the shortest range in the uranium and thorium families, tracks of less than 15 microns must have originated within the sample. Uranium and thorium contents, calculated in this way, are given in Table 1; it must be kept in mind that these are maximum values.

We have also determined a maximum value of 10^{-7} gm./gm. for the uranium and thorium concentration in the troilite phase of Toluca. We conclude that the uranium and thorium found by Paneth's group in Toluca (Hamburg) is not all localized in the troilite phase, since the resulting specific activity should have been easily detected under our experimental conditions. The relatively important degree of contamination has prevented us so far from deciding if the activity is concentrated in the intercrystal boundaries.

Our upper limit of $0{\cdot}6 \times 10^{-8}$ gm. uranium/gm. agrees with the results of Paneth and co-workers, but, of course, does not contradict those of Reed and Turkevitch. We hope in further experiments to lower our level of contamination by a factor of ten, which should clearly throw our findings in favour of one or the other of these contradictory results, and further our knowledge on the distribution of radioactive elements in meteorites.

Table 1. Uranium and Thorium Content (in 10^{-8} gm./gm.)

	Toluca (Hamburg)	Carbo
This work	$U < 0{\cdot}6$ $Th < 2$	$U < 0{\cdot}6$ $Th < 2$
Paneth's group results (ref. 1)	$0{\cdot}18 < U < 0{\cdot}22$ $2{\cdot}11 < Th < 2{\cdot}65$	$0{\cdot}54 < U < 0{\cdot}60$ $0{\cdot}49 < Th < 0{\cdot}87$

We wish finally to point out that a lower limit of the uranium and thorium concentrations in Toluca (Hamburg) can be obtained from its minimum radiogenic helium content[1], if we assume for it an age of $4{\cdot}5 \times 10^9$ years[9] and if we suppose that no radiogenic helium was lost. This comes out as: $U > 1{\cdot}5 \times 10^{-11}$ gm./gm.; $Th > 2 \times 10^{-10}$ gm./gm.

We are indebted to Prof. F. A. Paneth for supplying the sample of Carbo, and we wish to thank him and Prof. H. C. Urey for stimulating discussions. We thank the Institut Interuniversitaire des Sciences Nucléaires (Belgium) and the Theodor Kocher Institut (Berne) for financial support.

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Electric-breakdown Tracks in 'Perspex'

Mason[1] has shown that the short-time electric strength of polythene and other solid insulating materials may have an average value many times less than the intrinsic breakdown stress, because of the distortion of the field and the high local stress at the ends of discharges. Still to be explained, however, is the steepness of the breakdown voltage/time characteristic for 50 c./s. stresses of a few seconds duration.

In order to investigate this problem, polythene, 'Perspex', and polystyrene specimens have been broken down between needle-point electrodes in high-quality transformer oil at room temperature, provision being made to short-circuit the breakdown path in the specimen within a few micro-seconds of the breakdown. In this way, the nature of the breakdown channels may be observed in the absence of damage resulting from the passage of fault current (Fig. 1). A similarity, most pronounced in the 'Perspex' specimens, has been noted between the nature of the breakdown propagation and that of the streamer breakdown of air.

A ciné-film has been made of a breakdown in 'Perspex' sheet, $\frac{1}{2}$ in. thick, disposed as shown in Fig. 2, at 50 kV. r.m.s., 50 c./s., and the last section of this film is reproduced in Fig. 3. Each frame corresponds to successive third half-cycles, and the time taken for the breakdown to be propagated through the specimen was about 15 sec. When the film is projected at two frames per second ($\frac{1}{4}$ of normal speed) a step-by-step erosion from alternate points (probably as each becomes positive) may be seen.

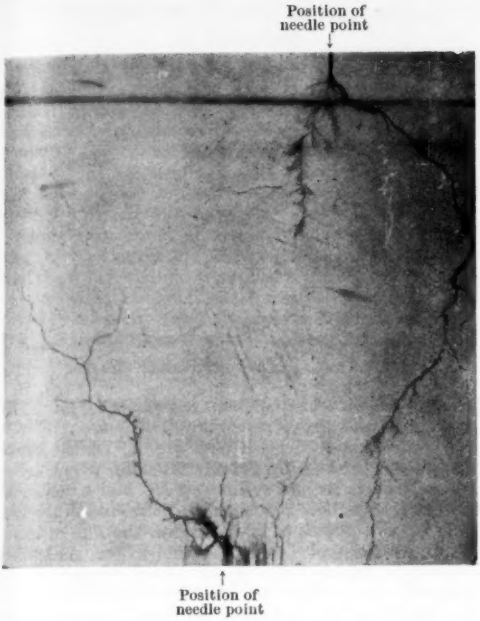

Fig. 1. Breakdown tracks in 'Perspex' undamaged by fault current

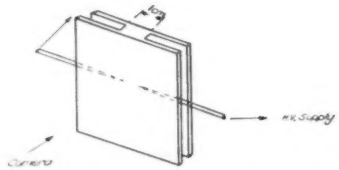

Fig. 2. Arrangement of specimen for ciné film of 50 c./s. breakdown in 'Perspex'

The evidence suggests that a possible mechanism of breakdown propagation from pointed electrodes (that is, needles or the ends of discharge streamers) is the flow of free electrons towards the positive electrode, permanent damage to the material occurring near to the ends of the channels where the current density is sufficiently high. The electrons may be excited from imperfection levels, possibly by radiation from discharges. This suggested mechanism would account for the random nature of many of the channels and for the fact that channels from opposite electrodes follow separate paths.

The breakdown mechanism described is observed to be a step-by-step process, cycle by cycle. The number of cycles to breakdown depends on the current density in the discharge channel, which itself depends upon the excitation and subsequent acceleration of initially trapped electrons. Because the current would depend strongly on the stress, the time to breakdown falls rapidly as the stress is increased.

Since this communication was prepared, my attention has been directed to some similar work which has just been published in Germany[2].

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[1] Mason, J. H., Inst. Elect. Eng. Monograph No. 127 (April 1955).
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Damping of the Earth's Free Nutation

The 'free nutation' of the Earth is a motion of the Earth's instantaneous axis of rotation around its mean position. The poles (intersections of the axis with the Earth's surface) describe changing orbits with the 'Chandler period' of about fourteen months. Every six or seven years the amplitude of these orbits reaches a maximum of up to ten metres and then decreases almost to zero. Following Jeffreys[1], Bondi and Gold[2] have considered that the free nutation has a characteristic damping time of the order of ten periods. They find that such heavy damping cannot arise from internal motion of the core or from relative motion between core and mantle, and conclude that it results from non-elastic behaviour of the mantle.

However, I doubt that the damping is as heavy as they suppose. Schweydar[3] has shown that the form and amplitudes of the observed complicated motion of the poles can be explained with a good approximation as a beat phenomenon between the free Chandler period of the Earth of about fourteen months and a periodic annual displacement of the Earth's axis of inertia. He found that the average annual movements of air masses from one hemisphere to the other alone should produce displacements of the poles of inertia with an average annual range of roughly three metres, which is enough to explain the amplitude of the nutation; there are appreciable variations from year to year due to changes in the meteorological conditions. On the other hand, observations of the uplift in formerly glaciated areas and the existence of deep-focus earthquakes indicate[4] that the mean time of viscous relaxation in the upper 700 km. of the Earth's mantle is at least of the order of a hundred years. From this a coefficient of viscosity of the order of at least 10^{21} poises may be derived. The period of only about seven years with which the amplitudes of the free nutation increase and decrease is probably short compared with the damping time of the nutation. Moreover, the energy transfer from atmospheric and other processes to the Chandler motion is unknown. Con-

Fig. 3. Last fifteen frames (left to right) of ciné-film of 50-c./s. breakdown developing in 'Perspex'

sequently, it does not seem possible to interpret the decay curve of the nutation and to discriminate the effect of damping from the beat phenomenon.

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Dec. 27.

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A New Theorem in Electrostatics and its Application to Calculable Standards of Capacitance

Although capacitance has the dimensions of length only, usually two or more separate lengths are needed to compute the capacitance of the various forms that have been used as standards. In seeking a form of calculable capacitor involving a minimum number of determinations of length, we have investigated cylindrical systems and have discovered a particular class of capacitor in which the capacitance depends on one length only to the first order. For example, if a square cylinder is constructed from four conducting planes which are insulated from each other at the corners, then the direct capacitances per unit length of cylinder, between each pair of opposing inside faces, are equal and independent of the size of the square. This direct capacitance was calculated as $\frac{\ln 2}{4\pi^2}$ cm./cm., and it was also calculated that if the cross-section was rectangular with a ratio of sides of $1 + \delta$, $\delta \ll 1$, then the mean of the two cross-capacitances was $\frac{\ln 2}{4\pi^2}\{1 + 3{\cdot}45\,\delta^2 + \ldots\}$ cm./cm. These calculations confirmed that, providing the asymmetry was not too great, a standard capacitor could be constructed which required only one length measurement for the computation of its capacitance. The length of the capacitor may be defined by insulating a length of one face from the remainder of that face, which remainder functions as a guard.

The capacitance per unit length and asymmetry effects were calculated for a number of other symmetrical cross-sections. These calculations all gave the same value, namely, $\frac{\ln 2}{4\pi^2}$ e.s.u., as the capacitance per unit length, and this result led one of us (D. G. L.) to propose and prove the following theorem:

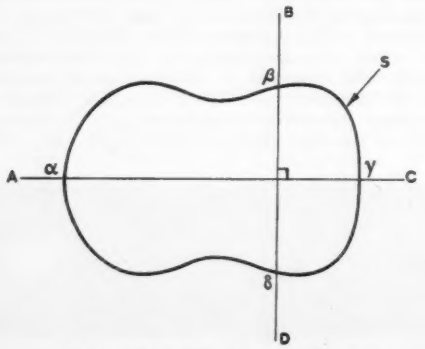

Fig. 1. Cross-section of cylindrical shell

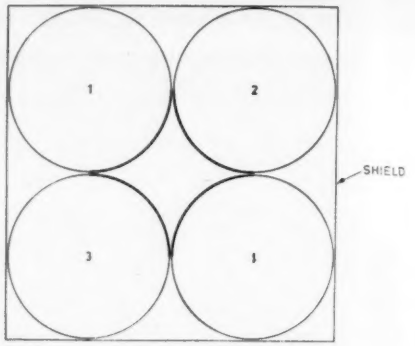

Fig. 2. Cross-section of experimental capacitor

Let the closed curve S (see Fig. 1) be the cross-section of a conducting cylindrical shell, which cross-section has one axis of symmetry AC but is otherwise arbitrary. Further, let this shell be divided into four parts by two planes at right angles, the line of intersection of the planes being parallel to the generators of the cylinder, and one of the planes containing the symmetry axis AC. Then the direct capacitance, per unit length of the cylinder, between opposing parts of the shell (for example, $\alpha\beta$ to $\gamma\delta$), due to the field inside (or outside) the shell, is a constant:

$$C_0 = \frac{\ln 2}{4\pi^2} \text{ e.s.u.} = 0{\cdot}0175576 \text{ e.s.u.}$$

As a consequence of this theorem, it is clear that the choice of the cross-section, for a cylindrical standard capacitor, is limited only by the requirements that the cross-section have one axis of symmetry and that it be a closed curve.

A cross-section which satisfies these requirements and at the same time is easy to realize in practice is that of the space between four circular cylinders the axes of which are arranged to lie at the corners of a square (see Fig. 2). Accordingly, a capacitor of nominal capacitance 1 pF (equivalent length, 20·151 in.) was constructed, using four pieces of stock silver-steel rod (nominal diameter, 15/16 in.) for the cylinders and suitably shielded externally so that only the inside field contributes to the capacitance. Two of the rods (2 and 4) were provided with end-guards to define their lengths and the rods were insulated from each other by mica spacers (0·004 in. thick) placed in the end guard region.

The cross-capacitances (1–4 and 2–3) were measured, and although they differed from the mean capacitance by as much as 0·3 per cent, this mean agreed to within one part in ten thousand with the capacitance calculated from the measured lengths of the guarded rods, due allowance being made for the dielectric constant of the air. It is proposed to construct a precision capacitor based on this design.

Full details of these investigations will be published elsewhere.

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Sydney. Nov. 2.

Oxidation as a Source of 'Anomalies' in Amylose

PEAT and his collaborators[1-3] have found that amylose prepared from potato, sago, maize and tapioca starch cannot be degraded by purified β-amylase or phosphorylase to an extent greater than about 70 per cent. Retrogradation of the amylose, which might have accounted for this, has been ruled out[2], leaving the implication that a proportion of the molecules of amylose have either an anomalous non-reducing end-group, or an anomalous group at some point along the chain. Peat, Thomas and Whelan[4,5] find that the anomaly can be removed by treating amylose with a β-glucosidase, termed *Z*-enzyme, and therefore suggest that it may result from the presence of a single glucose residue attached to the main chain by a link of β-configuration.

An alternative possibility is that the anomaly is an artefact introduced during the preparation of the amylose. This might happen through air-oxidation[6] during the isolation of the amylose, or, if the starch is a commercial sample, during the industrial processing of the starch.

To test this possibility, starch, freshly prepared from potatoes, was dispersed in neutral 1 per cent sodium chloride solution in the absence of oxygen, and fractionated as described previously[7]. Samples of the amylose fraction ('blue value' 1·3) were then treated with oxygen and their susceptibility to crystallized potato phosphorylase[8] compared with that of the untreated amylose.

The oxidized samples were prepared by blowing oxygen at 95° C. through portions of the amylose dissolved in (*a*) 0·5 *M* sodium hydroxide and (*b*) 0·01 *M* phosphate buffer, *p*H 7·1. The intrinsic viscosity of the amylose (measured in 0·5 *M* sodium hydroxide at 20° C.) fell in (*a*) from 3·09 to 1·13 in a treatment lasting 20 min., and in (*b*) to 0·98 in 8·75 hr. To enable a strict comparison to be made, a sample of the parent amylose was hydrolysed to an intrinsic viscosity of 1·02 by treatment with 0·1 *M* hydrochloric acid at 60° C. for 75 min. in an atmosphere of nitrogen. The three samples of degraded amylose were precipitated from neutral solution with butanol, and solutions prepared from the precipitates by steam-distillation under nitrogen.

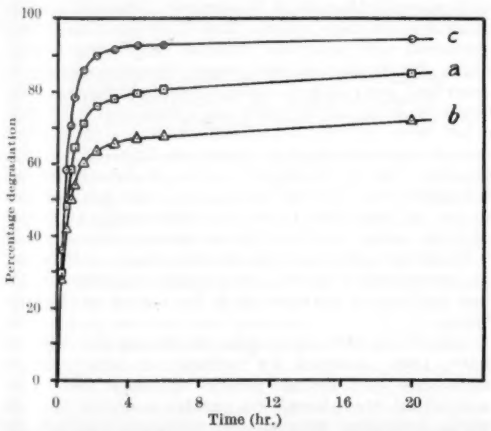

Fig. 1. Phosphorolysis of amylose. Curve (*a*), amylose previously oxidized in 0·5 *M* sodium hydroxide to $[\eta] = 1·13$; (*b*) amylose previously oxidized at *p*H 7·1 to $[\eta] = 0·98$; (*c*) amylose previously hydrolysed to $[\eta] = 1·02$

When incubated with phosphorylase in 0·2 *M* phosphate buffer, *p*H 6·6, at 38° C., the parent amylose was degraded smoothly to 90 per cent of theoretical. Degradation was measured by staining samples with iodine and measuring the optical density at 680 mμ. In a control to which phosphate was not added, there was no change in 24 hr. in intrinsic viscosity or in the optical density of the iodine stain. The phosphorylase was therefore free from α-amylase and *Q*-enzyme.

The three samples of degraded amylose were incubated simultaneously with phosphorylase under identical conditions. The results are shown in Fig. 1, in which degradation, expressed as the percentage fall in optical density of the iodine stain, is plotted as a function of time. It can be seen that a limit was quickly approached in all three cases, and from the values at 6 hr. the limit approximated for the hydrolysed sample to 92·8 per cent, for the sample oxidized in alkaline solution to 80·7 per cent and for the sample oxidized in neutral solution to 67·4 per cent of theoretical.

These results have been confirmed by duplicate experiments, and it is therefore clear that anomalies which limit phosphorolysis can be introduced into amylose by molecular oxygen, and also that such anomalies are not present to any appreciable extent in native amylose.

Two of us (H. B. and N. D. S.) are grateful to the Department of Scientific and Industrial Research for maintenance awards.

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Photochemical Oxidation of Alcohols by Dichromate

IN a recent communication in *Nature*[1] a table is presented of the reactivities per —OH group of a series of alcohols towards hydrogen-atom abstraction by photo-excited quinones. These values are very close to the relative reactivities of the alcohols to photo-excited dichromate solutions, for which approximate figures are available (Table 1)[2].

Table 1

Alcohol	Reactivity to Quinone	Reactivity to Dichromate
Methanol	0·12	0·3
Ethanol	1·0	1·0
n-Propanol	1·53	1·5
iso-Propanol	2·14	2·0
Glycerol	0·28	0·5

It might be concluded from this that the first reaction in photochemical oxidation by the dichromate ion is hydrogen atom abstraction from the organic molecule.

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Mechanism of Inactivation of Tobacco Mosaic Virus by X-rays

Inactivation of tobacco mosaic virus by X-rays has been studied by Gowen and Price, by Lea and associates[1] and by us[2]. The fraction surviving is an exponential function of dose with D_0 about $2{\cdot}3 \times 10^5$ r. This value corresponds to a target 3000 A. long and about 40 A. in diameter[2].

If the nucleic acid is the target, as proposed by Epstein[3], then it is possible that X-rays produce their lethal effect by breaking a nucleic acid chain. If this is true, then nucleic acid isolated from heavily irradiated tobacco mosaic virus ought to have a lower average particle-length than nucleic acid from unirradiated virus.

Since nucleic acid isolated from tobacco mosaic virus is a long, thin, fairly rigid rod[4,5], this theory can be put to test by measuring the intrinsic viscosity of isolated nucleic acid. To this end, 2 per cent solutions of tobacco mosaic virus were subjected to various doses of X-rays, and the nucleic acid was isolated by the method of heat denaturation[5]. The concentration of nucleic acid was determined from the height of the absorption maximum at 2570 A. The freedom from protein was verified by noting that the ratio of the extinction coefficients at 2600 and 2800 A. agreed closely with that of tobacco mosaic virus nucleic acid and differed greatly from that of the virus protein[6]. Results are shown in Table 1.

Table 1. Intrinsic Viscosity of Tobacco Mosaic Virus Nucleic Acid following X-irradiation

Intrinsic viscosity (ml./gm.)	Radiation dose (10^5 r.)	Intrinsic viscosity (ml./gm.)	Radiation dose (10^5 r.)
84	0	65	0·46
77	0	37	1·85
74	0	40	1·85

Nucleic acid isolated from X-irradiated virus has a lower intrinsic viscosity and, therefore, a lower average particle-length than that isolated from unirradiated virus. Therefore, the action of X-irradiation is to break the nucleic acid rods. That this breakage occurs as a result of damage inside the virus particle is indicated by the observations that heavily irradiated tobacco mosaic virus possesses essentially the same sedimentation-rate, intrinsic viscosity and electron image size as unirradiated virus. One can show, on the basis of simplified Simha theory, that the effect of breaking once each particle in an initially uniform distribution of rods, with the position of the break being equally likely at any point along the rod, would be to reduce the intrinsic viscosity to exactly one-half of its initial value. This calculation indicates that the order of magnitude is 1 for the number of breaks per rod associated with irradiation doses of about eight times the value of D_0 for inactivation.

This result is consistent with the view that the lethal action of X-rays on tobacco mosaic virus is the breaking of a single molecular chain anywhere in the nucleic acid. A possible reason for the discrepancy between the lethal dose and the dose required to break the rod is that the structure of ribose nucleic acid may be a coil of several strands.

An important deduction from these findings is that the biological activity of tobacco mosaic virus depends on the physical intactness of the nucleic acid. That a comparable degree of intactness of the protein is not required is indicated by the results reported by Schramm[4], to the effect that tobacco mosaic virus which has lost considerable protein still shows full biological activity.

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A New Unidentified Indole Hormone in Maryland Mammoth Tobacco

It has been reported previously[1] that the short-day plant, Maryland Mammoth tobacco, will flower under long day-lengths (14½–15½ hr.) if exposed to varying dosages of γ-rays. Recently, we have been investigating the effect of γ-radiation on the endogenous level of the indole compounds occurring naturally in leaf, stem, root and apical tissues of γ-irradiated and normal Maryland Mammoth tobacco. Large quantities of these tissues (300–1,000 gm.) have been extracted with absolute ethanol, employing a technique for extraction and paper chromatography as described previously[2]. Microlitre quantities of the extracts, after acidification and extraction with ethyl ether, were spotted on Whatman No. 1 filter paper and chromatographed in seventeen different solvents. Colours were developed with *p*-dimethylaminobenzaldehyde. 3-Indoleacetic acid was not detected in any of more than thirty-five individual extractions of leaf, stem, root or apical tissues of normal or γ-irradiated Maryland Mammoth tobacco. However, an unidentified indole compound was found in the leaf and apical extracts with R_F values as shown in Table 1.

Eluates of chromatograms containing the unknown have been assayed for activity in the split-pea curvature and tomato-petiole epinasty test. The compound was found to possess activity in both these biological assays. In addition, through the courtesy of Dr. K. V. Thimann and Dr. B. Stowe, of Harvard University, eluates of chromatograms containing the substance were tested and found to

Table 1. *Rf* VALUES IN SIX SOLVENTS FOR VARIOUS KNOWN INDOLE DERIVATIVES OCCURRING NATURALLY AND FOR AN UNIDENTIFIED INDOLE HORMONE IN NORMAL AND γ-IRRADIATED MARYLAND MAMMOTH TOBACCO

Compound	2-Propanol/ ammon./water (80 : 5 : 15)	2-Propanol/ ammon./water (10 : 1 : 1)	Ethanol (70 per cent)	Water	Water (chamber equilibrated with hydrochloric acid)	Water (chamber equilibrated with ammon. hydrox.)
Unidentified indole compound of tobacco	0·98	0·98	0·97	0·67	0·61	0·82
3-Indoleacetic acid (Eastman Kodak)	0·52	0·50	0·78	0·80	0·65	0·98
3-Indoleacetonitrile (Carbide and Carbon Chemicals Co.)	0·98	0·98	0·95	0·40	0·65	0·60
Ethyl ester of 3-indoleacetic acid	0·98	0·98	0·94	0·69	0·78	0·87

be active in the *Avena* curvature and straight-growth tests.

The compound is stable to alkaline treatment, labile to acids, possesses an ultra-violet absorption spectrum indicative of an indole ring system, and gives positive colours with Salkowski, Ehrlich's or Hopkins–Cole reagents.

In view of the absence of 3-indoleacetic acid in Maryland Mammoth tobacco leaf and apical tissue, and the presence of this physiologically active indole compound, it appears that we are dealing with a hitherto undescribed naturally occurring plant-growth hormone. The compound is not 3-indoleacetonitrile, which lacks activity in the pea-curvature test, and it does not appear to be the ethyl ester of 3-indoleacetic acid which, unlike the unknown, is hydrolysed by alkalis.

With the recent report of Luckwill and Powell[3] on the absence of 3-indoleacetic acid in the apple, evidence is accumulating that the hormonal regulation of growth in plants may not be restricted solely to the influence of 3-indoleacetic acid.

Details of this investigation will appear in the April–June issue of the *Contributions from Boyce Thompson Institute*.

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Inhibitory Action of Chlorpromazine on the Oxidation of D-Amino-Acid in the Diencephalon Part of the Brain

AMONG several substances examined in our laboratory for their influence on the activity of D-amino-acid oxidase, chlorpromazine (N-(3′-dimethylamino-propyl)-3-chlorophenothiazine hydrochloride) was found to be a powerful inhibitor of this enzyme. The inhibitory mechanism was investigated using a purified oxidase enzyme system and Warburg manometer, and the kinetic study carried out. D-Amino-acid oxidase protein was prepared from hog kidney by the method of Negelein and Brömel[1]. Each enzyme system consisted of apo-enzyme (protein *E*), $1{\cdot}6 \times 10^{-7}$ mole of flavin adenine dinucleotide prepared by the method of Yagi *et al.*[2], $6{\cdot}25 \times 10^{-2}$ mole of D-alanine. Amounts of chlorpromazine (supplied by Rhône-Poulenc-Specia) ranging from 2×10^{-5} to 4×10^{-4} mole were added to these enzyme systems.

The relation between D-amino-acid oxidase activity and flavin adenine dinucleotide concentration is

$$v = \frac{Vf}{K_F + f} \qquad (1)$$

where v is the reaction velocity in the presence of a concentration f of flavin adenine dinucleotide, V is the maximum velocity obtained by increasing the concentration of flavin adenine dinucleotide, and K_F is independent of f and V. Using this formula, the dissociation constant of flavin adenine dinucleotide with oxidase protein was calculated as $1{\cdot}1 \times 10^{-7}$ *M*.

If an inhibitor acts by combining with oxidase protein competitively with flavin adenine dinucleotide or by forming a complex with flavin adenine dinucleotide, and $K \gg K_F$, the activity of the enzyme can be represented by the following formula, as described by Burton[3]:

$$v = \frac{Vf}{K_F\,(1 + i/K) + f} \qquad (2)$$

where i is the concentration of inhibitor and K is its dissociation constant from its complex with oxidase protein or with flavin adenine dinucleotide.

If v_0 is the reaction velocity in the absence of inhibitor, from equation (2)

$$\frac{v_0}{v} = 1 + \left\{1 - \frac{v_0}{V}\right\} \frac{i}{K} \qquad (3)$$

and K can be evaluated.

In an experiment, the values of v_0/v plotted against the concentration of chlorpromazine (i) gave the straight line, the slope of which was $1{\cdot}8 \times 10^4$ l./mol.; and the values of v_0 and V were 41·5 μl. and 70·5 μl. of oxygen uptake in 30 min. respectively. From these values, K was calculated as $2{\cdot}3 \times 10^{-5}$ mol./l. The possibility of a complex forming between chlorpromazine and flavin adenine dinucleotide was excluded by measuring extinction and fluorescence.

It is therefore concluded that the inhibitory mechanism of chlorpromazine on D-amino-acid oxidase can be attributed to competition with flavin adenine dinucleotide.

These observations suggested that chlorpromazine inhibits the flavin enzymes in brain tissue. As chlorpromazine is believed to have an influence on the diencephalon, the inhibitory action of chlorpromazine on enzymes with which flavin is concerned has been investigated. The activity of a homogenate of the diencephalon (comprising the thalamus, metathalamus, epithalamus and posterior part of hypothalamus) was therefore investigated. The oxygen uptake of a homogenate of the diencephalon freshly excised from a dog was measured manometrically. The endogenous respiration of the homogenate was inhibited by cyanide. In the presence of cyanide, it was able to catalyse the oxidation of D-alanine, and was activated by the addition of flavin adenine dinucleotide. It was markedly

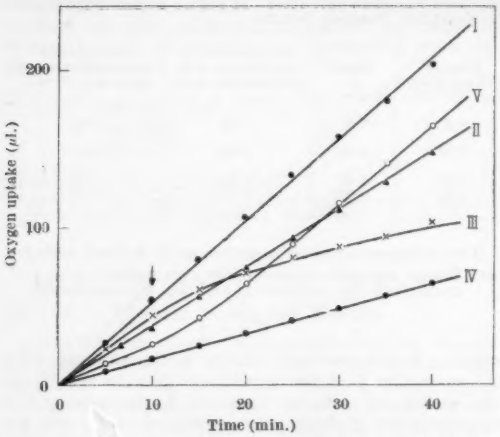

Fig. 1. Inhibitory action of chlorpromazine on the oxidation of D-alanine by a homogenate of diencephalon. Curves I–V show the oxygen uptake of the following reaction mixtures in a total volume 1·8 ml. in each cup: Curve IV, pyrophosphate homogenate (*p*H 8·3) of 500 mgm. of wet diencephalon and *M*/900 potassium cyanide (final concentration). Curve II, same as IV + D-alanine (final concentration, $5·5 \times 10^{-2}$ *M*). Curve I, same as II + flavin adenine dinucleotide (final concentration, $1·4 \times 10^{-5}$ *M*). Curve III, same as II + flavin adenine dinucleotide (final concentration $1·4 \times 10^{-7}$ *M*) + chlorpromazine (final concentration 2×10^{-3} *M*) after 10 min. Curve V, same as II + chlorpromazine (final concentration, 2×10^{-3} *M*) + flavin adenine dinucleotide (final concentration, $1·4 \times 10^{-5}$ *M*) after 10 min.

inhibited by the presence of chlorpromazine, and was recovered by the addition of flavin adenine dinucleotide, as shown in Fig. 1. The activity in this reaction mixture can be attributed to D-amino-acid oxidase in this tissue.

From these results, it is considered that chlorpromazine will decrease the oxidation of the diencephalon by inhibiting its flavin enzymes in competition with flavin adenine dinucleotide. These results may have some connexion with the pharmacological action of chlorpromazine.

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Glucagon and the Regulation of Carbohydrate Metabolism

There is considerable experimental evidence that glucagon (hyperglycæmic factor of the pancreas) is a true hormone which originates in the α-cells of the islets of Langerhans[1]. Its isolation and crystallization were reported in 1953[2]. The crystalline material appears to be a simple protein with a molecular weight of approximately 4,200 and an amino-acid content which differs significantly from that of insulin[3]. Minute doses of crystalline glucagon (0·1γ in the cat) cause a significant rise in blood sugar[3]. This effect is probably brought about by a stimulation of liver glycogenolysis, since glucagon has been shown to increase the net synthesis of liver phosphorylase[4]. Further than this, little is known about the action or physiological role of glucagon. Current speculation revolves about three possibilities: (*a*) that glucagon is an anti-insulin hormone[1], (*b*) that it is an insulin synergist[5], or (*c*) that it has no significant function in the control of carbohydrate metabolism[6].

I wish to report briefly some experiments on the effect of glucagon and insulin alone and in combination on the utilization of peripheral glucose, and to propose a theory of the role of glucagon in the regulation of carbohydrate metabolism. Detailed experimental results are being published elsewhere[7].

Fifty-six men (ages twenty-one to forty-seven) considered normal with respect to carbohydrate metabolism, and in good general health, were studied under controlled basal conditions. All subjects were kept under hospital conditions and on a high carbohydrate diet for several days before the experiments, which were done in the morning after a 14-hr. fast and 30–60 min. of bed rest in a special room. The effects of glucagon and/or insulin on arterial (capillary) and venous blood-sugar levels were studied for 60–110 min. following a control period of 30–60 min. during which glucose alone was infused. (Glucagon and glucagon-free insulin were kindly supplied by Drs. Behrens and Kirtley, of the Eli Lilly Co.) Frequent blood samples (30–40 per subject) were drawn without stasis and analysed for glucose by the Nelson–Somogyi method[8].

The results showed that glucagon causes a highly significant increase ($P = 0·001$) in the difference between arterial and venous glucose. These findings confirm results previously reported from this laboratory using a different experimental procedure[9]. Insulin also increased the difference between arterial and venous glucose significantly ($P = 0·01$), as would be expected. When both insulin and glucagon were administered together, the differences between arterial and venous glucose were significantly greater ($P = 0·001$) than those with either glucagon or insulin alone. Fig. 1 summarizes the results from the three experimental groups with respect to values for the ratio of the difference between arterial and venous glucose to the concentration of arterial glucose, which have been shown to be proportional to the specific rate constant of peripheral glucose utilization under the special conditions of the experiments[7b].

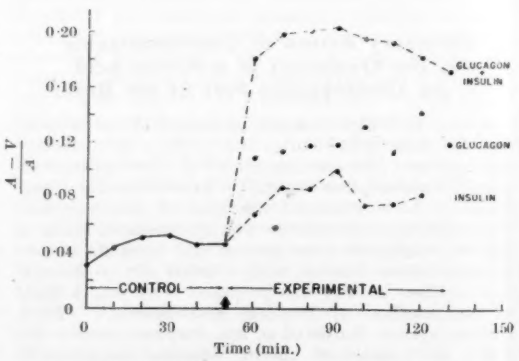

Fig. 1. Each point of control period represents the median value of 54 subjects, whereas each point of the three experimental groups represents the median of 12 subjects. The ratio of the differences between arterial and venous glucose to the concentration of arterial glucose is proportional to the specific rate constant of utilization of peripheral glucose. *A*, arterial glucose concentration; *V*, venous glucose concentration

These findings suggest that (*a*) glucagon has a dual, integrated action, namely, the release of liver glycogen and the enhancement of peripheral glucose utilization, and that (*b*) glucagon and insulin may function jointly to accelerate the peripheral utilization of glucose. Since the two hormones have opposing actions on blood glucose and the levels of liver glycogen, each is well suited to complement the effect of the other in the task of maintaining these two reservoirs of body glucose constant in the face of an accelerated rate of utilization of peripheral glucose.

This mechanism remains to be clarified. Studies in the depancreatized dog[7a] indicate that the effects are not due to a secondary release of insulin. Furthermore, the increases in the ratio of the difference between arterial and venous glucose to concentration of arterial glucose values with glucagon were significantly greater ($P = 0{\cdot}001$) than those observed with comparably high blood-glucose levels obtained by glucose alone[7a]. Hence the hyperglycæmic action *per se* of glucagon is not an adequate explanation for the results observed. Preliminary experiments in the hepatectomized dog (Elrick, H., Rachiele, F., Stoll, F., and Arai, Y., unpublished observations) suggest that the liver is necessary for the enhancing effect of glucagon on peripheral glucose utilization.

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Spasmolytic Effect of Cerebral Tissue Extracts

USING isolated segments of the guinea pig intestine suspended in oxygenated Tyrode solution at 35° C., strong contractions induced by acetylcholine and adenosine triphosphate were relaxed by introducing concentrated extracts of rat brain in Tyrode solution[1].

When dried red-cell stroma extracted with Tyrode solution was similarly tried, relaxation of acetylcholine contractions occurred immediately, but adenosine triphosphate contractions were not affected. Investigation was then carried out into the possible presence of a relaxing agent other than choline esterase in brain extracts.

Fig. 1. Trendelenburg's preparation. Intraluminar pressure = 3 cm. water. Upper tracing: peristalsis. Lower tracing: longitudinal movement. At *A*, 0·4 μgm./ml. crude sphingosine (pH 7·4). Duration of tracing, 6 min.

A special extract was prepared from cow brain consisting of crude sphingosine bases[2,3] in Tyrode solution, and this, when added to the guinea pig intestine in an organ-bath to make a final concentration of 0·4 μgm./ml., abolished contractions induced by adenosine triphosphate as well as by acetylcholine in a manner similar to whole brain extracts[1].

Using Trendelenburg's preparation[4], it was shown that peristalsis in the guinea pig intestine was abolished by the extract at a concentration of 0·4 μgm./ml. There was a concomitant loss of tone (Fig. 1). Pendular motility in the isolated rabbit intestine was abolished, in some cases after an initial transient spasm. This preparation also showed reduction in tone (Fig. 2).

A more purified fraction (triacetylsphingosine[2]) showed qualitatively similar effects when tested on the isolated rabbit intestine. Larger amounts of this substance were required to demonstrate a definite effect (16 μgm./ml.) and pendular motility and tone only gradually diminished.

These effects of sphingosine were not reversed in any of the tests by washing away the bases. They

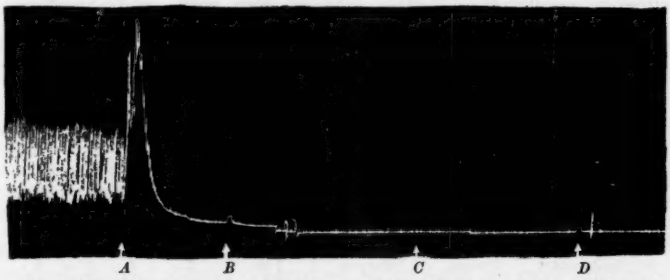

Fig. 2. Rabbit jejunum. At *A*, 0·4 μgm./ml. crude sphingosine (pH 7·4). Washing at *B*, *C* and *D*. Duration of tracing, 40 min.

showed the irreversible character observed when atropine is used as an antagonist of acetylcholine in concentrations greater than 0·05 μgm./ml.

It appears, therefore, that sphingosine and allied bases in cerebral tissue may exert a powerful spasmolytic action *in vitro*.

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Lipæmia Clearing Action of Sulphated Animal Hyaluronate

Heparin has now been shown to exert a lipæmia clearing action *in vivo*, and is believed to operate primarily by liberating a lipase which catalyses the lipolysis of chylomicrons and low-density lipoproteins[1].

Constantinides and co-workers[2] have shown that several sulphated synthetic polysaccharides, all of which react metachromatically with toluidine blue, may also exert lipæmia clearing activity, apparently operating in the same manner as heparin. Later, Gutmann and Constantinides[3] demonstrated that sulphated alginic acid may even inhibit experimental atherosclerosis in the rabbit. The work of Constantinides and collaborators indicated further that, at least for synthetic polysaccharides, sulphation is an essential for providing these synthetic agents with both their metachromatic staining capacities and their lipæmia clearing activities.

Since heparin is itself a sulphated uronic acid derivative, it was therefore considered possible that other naturally occurring metachromatic staining mucopolysaccharides, and especially those widely distributed in the connective tissues generally and in arterial ground substance in particular, may also exert lipæmia clearing activity. This possibility was tested, in part, by the following experiments.

Twenty-eight male albino Wistar-strain rats weighing 300–400 gm. were used. All animals were starved for 20 hr. before beginning an experiment. Three and a half hours before bleeding by cardiac puncture, they were given 3 ml. of maize oil intragastrically; twenty minutes before bleeding, they were anæsthetized lightly with intraperitoneal pentobarbitone. Immediately before bleeding, they were given a light supplementary ether anæsthesia; the thoracic cavity was then rapidly opened and 3 ml. of right ventricular blood was withdrawn and transferred to chilled heparinized tubes. After centrifuging, an independent observer graded each specimen of plasma, macroscopically, as 0–5 degrees of turbidity.

The preparations tested for anti-lipæmic (or rather anti-chylomicron) action were given in the dosages, by the routes, and at the times before bleeding indicated in Table 1. In addition to this, cortisone, hyaluronidase and toluidine blue were tested for lipæmia clearing activity on a further twenty-seven rats. Details relating to the latter group of substances are not given here, since they all failed both to clear the plasma of macroscopically visible chylomicrons and to prevent the lipæmia clearing activity of intravenous heparin when administered after these preparations. From Table 1 it seems that: (*a*) heparin acts as a lipæmia clearing agent when injected 15 min. prior to death; this confirms previous findings in this regard; (*b*) hyaluronidase fails to inhibit chylomicronæmia when injected intramuscularly prior to fat feeding or intravenously after fat feeding, despite its known effects in mobilizing tissue endogenous mucopolysaccharide; (*c*) non-sulphated, animal umbilical cord hyaluronic acid is apparently erratic in its lipæmia clearing action when given before or after lipæmia has been induced; the sulphated animal umbilical cord hyaluronate is active in the rat when injected both 24 hr. and 1 hr. prior to fat feeding or, alternatively, 3 hr. after fat feeding.

Preliminary studies on monkeys indicate that plasma, drawn from a fasted animal 15 min. after an intravenous injection of sulphated hyaluronate, exerts a lipæmia clearing action when incubated with lipæmic plasma from a control monkey fed with fat. Thus, sulphated hyaluronate also has a lipæmia clearing action *in vivo* in monkeys and probably operates, at least in part, through a similar mechanism to heparin, the sulphated synthetic polysaccharides tested by Constantinides *et al.*[2] and the inorganic salts used by Bragdon and Havel[4].

These findings strongly suggest that heparin is not unique, as a naturally occurring sulphated mucopolysaccharide, in showing lipæmia clearing activity, but that other sulphated tissue mucopolysaccharides may have a similar action.

It is tentatively suggested that the deposition of lipid in connective tissue generally, and in arteries in particular, may be a function of the sulphated mucopolysaccharide metabolism throughout the organism. The possibilities of naturally occurring sulphated mucopolysaccharides taking a critical role in fat deposition in depots and in arteries, normally and in disease processes, and that they may even be capable of promoting the absorption of pathologically deposited lipid in arteries, are being actively investigated in our laboratories.

The expenses of this investigation were defrayed by a generous grant from the Schlesinger Organization, South Africa. We also wish to thank Dr. Robert L. Craig, of Messrs. D. G. Searle and Co., Chicago, for providing the sulphated hyaluronate used, and Mr. R. N. Tuck and Mr. H. F. Sadler, of Wyeth (Pty.),

Table 1. Anti-chylomicronæmic Action of Substances tested on Rats given 3 ml. Maize Oil Intragastrically

Preparation	Dosage	Route	Time before bleeding	No. of rats in group	No. of rats with degrees of lipæmia indicated		
					0–1	2–3	4–5*
Nil (controls)	—	—	—	5	1	3	1
Heparin	400 units	Intraven.	½ hr.	3	3	0	0
Hyaluronic acid	5 mgm.	Intraven.	½ hr.	6	3	0	3
SO_4-Hyaluronate	2 mgm. + 2 mgm.	Intraperit. Intraperit.	24 hr. 3½ hr.	8	8	0	0
SO_4-Hyaluronate	2 mgm.	Intraven.	½ hr.	3	3	0	0

* 4–5 indicates marked opalescence of plasma at 3½ hr. after feeding oil.

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Di- and Mono-Taurobilirubin similar to a Directly Reacting Form of Bilirubin in Serum

IN the course of investigations into the colloidal properties of bilirubin, it was found that inhibition of the diazo-reaction in acid solution is caused by the association of bilirubin with the formation of colloidal solutions of bilirubin. The diazo-reaction at acid *p*H occurs only if bilirubin remains in the monomolecular state[1].

Bile acids become more soluble after combination with taurin and glycine. The aim of our work was to cause a similar change in the chemical constitution of bilirubin and to combine both free carboxyls of bilirubin with taurin. We used the method described recently for the synthesis of peptides by Boissonnas, Vaughan and Osato[2]. The same method has been used in the synthesis of conjugated bile acids by Bergström and Norman[3]. In preparing conjugated bilirubin the experimental conditions were the same as described in that method. We obtained a chemical compound, ditaurobilirubin, which differed from free bilirubin by its solubility in acid solutions. The diazo-reaction at an acid *p*H was direct. The spectrum of the new compound in dioxan and water was identical with that of free bilirubin. The new pigment gave a positive Gmelin reaction, which is, according to Fischer, typical for bilirubin and other tetra-pyrrolic pigments[4]. The infra-red spectrum of the new pigment confirmed the disappearance of free carboxyl groups as compared with bilirubin. The synthetic pigment changed in water medium, especially when acidified with strong acids, and the yellow colour of the solutions changed into green (possibly taurobiliverdin).

When the experimental conditions for the preparation were slightly changed, two pigments were obtained, one of which, possibly monotaurobilirubin, migrated on paper electrophoresis with half the speed of the other (possibly ditaurobilirubin). The slowly migrating pigment gave a slightly delayed diazo-reaction as compared with the other.

The pigments were separated by paper chromatography with a chloroform/methanol/acetic acid system, and in the same way two pigments in addition to bilirubin were isolated from the serum of a patient with hepato-dystrophy, and also from various specimens of duodenal bile.

In all experiments (using synthetic and natural material) the more polar pigment remained at the starting point and gave a direct diazo-reaction. The less polar synthetic pigment migrated with a slightly lower R_F than the natural pigment, free bilirubin migrating with the solvent front. As with direct chromatography of serum bilirubin, reversed phase chromatography of synthetic products, according to Cole, Lathe and Billing[5], yields two pigments besides bilirubin.

The preparation of other similarly substituted bilirubin derivatives has been undertaken. Their chemical properties and elemental analyses will be described elsewhere.

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Production of Opacity on Serum Agar Plates by Some Strains of *Staphylococcus aureus*

IN 1941, one of us (A. J. H. T.) observed that about half the strains of *Staphylococcus aureus* isolated from the skin lesions of impetigo contagiosa had two properties not often seen in strains from other sources, namely, the ability (*a*) to inhibit the growth of corynebacteria on solid media, and (*b*) to produce zones of opacity on serum agar plates. In a recent investigation of impetigo in south-east Lancashire, it was found that 80 per cent of strains of *Staph. aureus* belonged to one phage type (Type 71), most members of which inhibited the growth of corynebacteria and were resistant to penicillin[1]. More than 95 per cent of the Type 71 strains also produced opacity zones on serum agar plates.

The production of opacity on serum media by *Staph. aureus* has been little investigated, though its occurrence was noted by Woods and Parkin[2]. The zone of opacity extends for 1·0–1·5 mm. beyond the growth and is best seen after 15–18 hr. incubation aerobically at 37° C. The reaction is best demonstrated on infusion broth agar containing 5 per cent fresh horse serum. Substantially the same results are obtained with human serum; but reactions with rabbit serum are rather less frequent and intense. No opacity occurs when the plates are incubated anaerobically or when the infusion agar base is replaced by 'Lemco' broth agar or by 'Oxoid' nutrient agar.

The ability to produce opacity is unevenly distributed among *Staph. aureus* strains. It occurs commonly only among two sorts: Type 71 strains from skin infections and penicillin-resistant Group III strains[3] from superficial infections acquired in hospital. Also, it is remarkable that strains producing opacity on serum agar are most uniformly negative to the egg-yolk reaction of Gillespie and

Alder[4]. Of 908 strains, from a variety of sources, 332 gave a positive serum opacity reaction and 498 were egg-yolk positive, but only two were positive to both tests.

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Production of Gliotoxin in Soils

Since the majority of micro-organisms which are known to produce antibiotics are soil inhabitants, there has been considerable speculation whether they can produce these antibiotics in their natural environment. It is now generally accepted that if antibiotics are produced in the soil, this would probably occur in localized micro-environments where there is a favourable food supply, such as around particles of plant debris or in the rhizospheres of certain plants.

So far no one has reported success in demonstrating the production of an antibiotic in normal soil; but it has been shown that some soils, when enriched with organic matter and inoculated with an organism known to produce an antibiotic, will support production of an active substance[1,2]. I have shown[2] that gliotoxin can be produced in soil supplemented with plant material and inoculated with *Trichoderma viride*.

To determine whether antibiotic production is localized in the vicinity of plant debris, pieces of wheat straw (1 in. long) were introduced into an acid podsol from Wareham Heath inoculated with a spore suspension of *T. viride*. After seven days the straws and the soil surrounding the straws were each separately extracted with ether and the extracts tested for antibiotic activity. An active substance was present and was identified as gliotoxin by paper chromatography. The amount of gliotoxin present could be estimated roughly from the size of an inhibition zone produced on agar seeded with *B. subtilis*.

Straws from inoculated soil were covered with a good growth of *T. viride* and produced approximately 1 μgm. gliotoxin/straw, whereas those from uninoculated soil produced no activity. The inoculated soil immediately surrounding the straws yielded approximately 1 μgm. gliotoxin/gm. soil. This is a much lower yield than that from an equivalent weight of straw (13 μgm. gliotoxin/gm. straw). It would seem that either the gliotoxin was produced only in the straws and then began to diffuse out into the soil, or that the fungus, using the straw as a food base, grew out into the soil and produced some gliotoxin there. No gliotoxin was produced in straws buried in a Kettering loam of *p*H 6·3 unless either the straws or the soil was first acidified.

During the course of an experiment in which mustard seeds were dusted with spores of *T. viride* in an effort to protect the seedlings against soil-borne diseases, it was noticed that in some cases the seedlings developed chlorotic patches on the cotyledons. As the damage was very similar to that produced on seedlings which had been grown in solutions of gliotoxin, it seemed possible that gliotoxin was produced around the seedling, probably in the seed coat. After the seeds had been dusted with spores of *T. viride* and grown in John Innes potting compost for seven days, the seed coats were removed and placed on agar plates seeded with *B. subtilis*. Zones of inhibition were produced around the coats which had been inoculated with *T. viride* spores but not around the uninoculated control coats. The seed coats were extracted with ether, and the active compound was shown to have R_F values identical with gliotoxin on paper chromatograms. It was estimated that approximately 0·25 μgm. gliotoxin was produced per seed coat. Pea seeds treated in the same way were found to produce 4 μgm. gliotoxin/seed coat.

When these experiments were repeated with a new batch of potting compost it was found that an antibiotic was also produced on uninoculated pea coats. This active substance was both antibacterial and antifungal, and was found to have similar R_F values to gliotoxin in several solvent systems.

The fungus which was isolated from the pea coats grown in the new batch of potting compost was identified as *T. viride*, and was found to produce high yields of gliotoxin in Weindling medium. The *Trichoderma* was not a contaminant of the seed coat but was isolated repeatedly from the soil.

These experiments have shown that high concentrations of an antibiotic can be produced in and around particles of organic matter, such as pieces of straw and seed coats, buried in soil. In a batch of John Innes potting compost in which a gliotoxin-producing strain of *T. viride* formed part of the natural flora of the soil, the fungus grew on the seed coats and produced gliotoxin there. This is an example of antibiotic production in an uninoculated soil in the vicinity of a very natural organic supplement.

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Lactophenol Preparations for Soil Nematodes

One of the essentials of a fluid preparation for nematodes is that coverslip supports must be included in the drop of mounting medium to avoid distortion of the specimens. For this purpose Goodey[1] recommends glass fibres arranged radially in the drop; but as the fibres may be of varied and unknown diameter, it is difficult to judge the correct size of drop. If the drop is too large, the lactophenol flows on to the upper surface of the coverslip, and the ringing medium ('Zut' or lactophenol gum) will not seal the mount. If the drop is too small, air spaces are left near the edge of the coverslip and the ringing medium is drawn into them by capillarity.

This difficulty has been overcome by using lengths of 80/20 nickel–chromium resistance wire as coverslip

supports (Brightray 'C', H. Wiggin and Co., Ltd., Birmingham 6). This is manufactured to a tolerance of ± 2·6μ for the following diameters: 25μ (50 standard wire gauge), 30μ (49 s.w.g.), 40μ (48 s.w.g.), and 50μ (47 s.w.g.). As the diameter of the coverslip support is both known and constant, the required drop size can be calculated and delivered on to the slide by a micropipette fitted with a 'Pumpett' attachment. Wire of slightly greater diameter than that of the largest specimen is selected for each mount, and is cut in lengths approximately equal to one-third of the coverslip diameter. The pieces of wire are arranged radially in the drop, the specimens are added, and a warm coverslip is lowered on to the preparation. With the correct drop size the lactophenol fills exactly the space under the coverslip.

There has been no visible evidence of reaction between the nickel–chromium wire and lactophenol in slides which have been left for six months. The method saves time, and because remounting is seldom necessary, specimens are less likely to be lost or damaged.

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Accelerated Storage Tests for Dehydrated Vegetables

When dehydrated vegetables are stored at high temperatures (for example, in the tropics) they eventually become unacceptable, usually because of the development of brown pigments. Since many different factors, not precisely controllable, affect the rate at which the brown discoloration develops, it is virtually impossible to predict the storage life of the dehydrated product. Examination of the behaviour of dehydrated vegetables held at 37° C. has been the usual way of studying the effects of variables on 'tropical' storage life; but such tests may be prolonged and delay research, while they are of little value to a manufacturer or purchaser who may need information before dispatching or purchasing the material.

The rate of development of browning is directly related to the temperature of storage between about 25° and 50° C. [1], and it has been suggested that the reactions involved in the development of the brown pigments at temperatures between 25° and 70° C. are similar[2]. It seemed possible, therefore, that storage at temperatures higher than 37° C. might enable a prediction to be made, in a relatively short time, of the rate at which browning would occur at the latter temperature.

Tests carried out at 37°, 55° and 70° C., in which samples after reconstitution and cooking were judged by an experienced taste panel, showed that at 70° C. browning was too rapid for accurate assessment, but that for a number of dehydrated vegetables the rate of browning at 55° C. was approximately thirty times that at 37° C.; that is to say, storage for a certain number of days at 55° C. and for the same number of months at 37° C. caused similar degrees of browning.

In subsequent tests on dehydrated potato, more accurate methods of assessment were sought. The pigment was, in all but the most severely browned samples, completely soluble in 66 per cent ethanol, and a value for the extent of browning could be obtained by measuring the optical density of the resulting extracts at 400 mμ in a spectrophotometer. For large numbers of samples, however, this method was too slow, and a quick method was devised, in which the samples under examination were compared visually with a set of colour standards.

The standards were prepared by 'kibbling' dehydrated potato strips in a hammer mill, and using the fraction retained by a 16-mesh sieve but passing a 6-mesh sieve. The kibbled material was packed in nitrogen in Kilner jars and held at 55° C. for varying periods. A range of colours was selected from the browned material so produced, and assigned marks from 1 to 8, 1 being excessively brown and 8 being completely free from browning. When not in use the standards were stored in the dark at − 5° C. The material under test was kibbled, packed in nitrogen in Kilner jars in the same manner as the standards, and put into storage at the desired temperature. At intervals the test material was compared with the standards and awarded marks accordingly.

To check the validity of this visual colour scoring, a number of samples were tested both in this way and by measuring the optical density of the 66 per cent ethanol extract. The results were in satisfactory agreement: calculation of the correlation coefficient showed $r = -0{\cdot}90$. Similarly, the visual test results and the scores for colour obtained by the taste panel were also closely correlated ($r = +0{\cdot}94$).

In two successive years, the visual method was used to test the earlier finding that the rate of browning in dehydrated potato at 55° C. was approximately thirty times that at 37° C. The marks for material stored for 2, 3, 4, 5 and 6 days at 55° C. were plotted on the horizontal axis (x) against marks given to a sample of the same material after 2, 3, 4, 5 and 6 months respectively at 37° C. (y). Fig. 1 shows the results for 1954: the correlation coefficient was $r = +0{\cdot}91$ and the line of best fit to the pairs of readings was $y = 0{\cdot}989x - 0{\cdot}013$. Generally similar

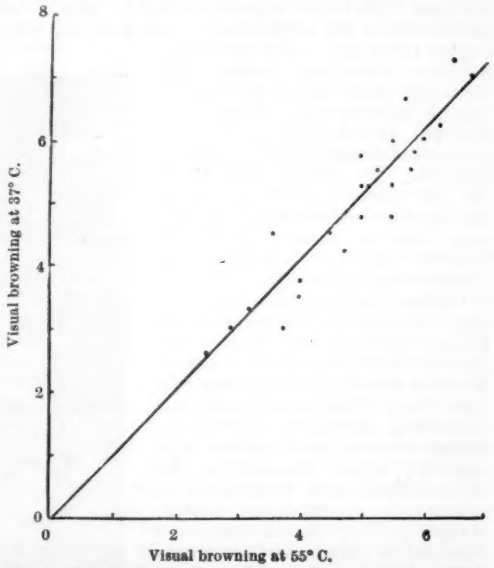

Fig. 1. Regression of visual browning after months at 37° C. upon visual browning mark after the same number of days at 55° C. (dehydrated potatoes, 1953–54). $y = 0{\cdot}989x - 0{\cdot}013$; $r = +0{\cdot}91$

results, though with somewhat wider scatter, were found in 1955 (correlation coefficient $r = +0{\cdot}81$ and line of best fit $y = 1{\cdot}028x - 0{\cdot}041$).

These results support the general thesis that the extent of browning developed in dehydrated potato during storage for a certain number of days at 55° C. is approximately the same as that developed during the same number of months at 37° C. It is evident that accelerated tests at 55° C. could be of value to both manufacturers and purchasers of dehydrated vegetables.

We are indebted to Mr. J. M. Harries for the statistical analyses.

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Regeneration of Yeast Cells from Naked Protoplasts

Observations of the ability of cell fragments to re-form into new cells are very old[1]. Many experiments have been carried out on Protozoa and Algae especially, and importance of the nucleus for regeneration has been ascertained.

In our experiments we have investigated the power of regeneration in cell fragments of yeasts (*Saccharomyces cerevisiae*). The fragments were obtained in two ways: (1) By mechanical pressure on yeast cells the plasma flows out and takes up the form of droplets (Fig. 1), producing a large number of plasma droplets, but only one of which contains the whole nucleus; some physical properties of plasma can easily be studied with these plasma droplets[2]. (2) Under certain conditions, lysis of cell membranes in the surface layer of the autolytic yeast culture takes place. The protoplast becomes loose and breaks into several droplets. A very similar process in bacteria was described by Weibull[3], who has deprived the bacterial cell of a membrane by means of lysozyme. In our experiments we did not succeed in demonstrating the free hemicellulases and we presume that the yeast membrane is lysed by ferments which are closely bound to the protoplast.

Plasma droplets thus obtained can be transferred to nutrient media, though they are very fragile, and their further behaviour observed. We have transferred the droplets on agar with synthetic nutrient medium containing asparagine. Most of the plasma droplets die off in a few days, especially those obtained by the mechanical method. Others grow intensively for several hours. Growth is rapid and large plasma formations arise out of plasma droplets during 24 hr. (Figs. 2 and 3). The volume of plasma formations is ordinarily a thousand times bigger than the

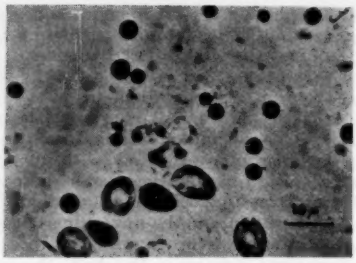

Fig. 1. Droplets of free plasma obtained by mechanical pressure on yeast cells. Phase-contrast. × 750

volume of a single yeast cell; they have no membrane and therefore an irregular outline. The plasma is homogeneous, with many vacuoles. Plasma formations are often broken up, and the separated parts go on growing independently. I have shown elsewhere[4] that the growth is not dependent on physical changes only of the plasma droplets, but that there is real growth connected with quantitative increase of plasma. In another investigation[5] it was demonstrated that only the plasma droplets containing the nucleus develop; those without it die off. In the later stages of development the plasma formations always contain more nuclei, which are structurally rather different from the nucleus of the normal yeast cell. Neither Weibull[3] nor others[6,7] observed similar growth and the division of protoplasts after lysozyme lysis of bacterial membrane, though protoplasts invariably remain alive, as is obvious from their metabolism[6] and ability to form the bacteriophage[7,8].

Some of the plasma formations developed degenerate after a few days without having changed essentially; but others display further developmental changes. The plasma contracts, vacuoles disappear, the plasma viscosity increases and there develop dense spherical formations, often of a large size (30–40μ). They, too, contain a greater number of nuclei which are exactly like normal nuclei. If we

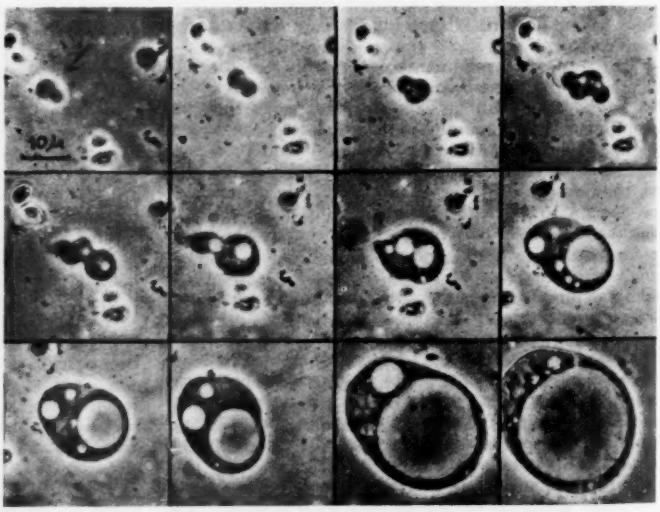

Fig. 2. Several stages in the evolution of a single plasma droplet into plasmatic form. Time-lapse photography, at intervals of about 2 hr. × 750

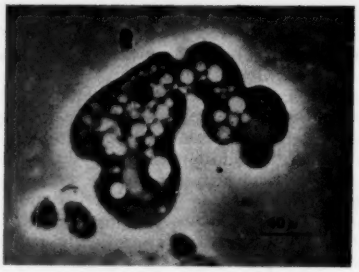

Fig. 3. A large plasma formation developed by growth from a plasma droplet. Phase-contrast. × 750

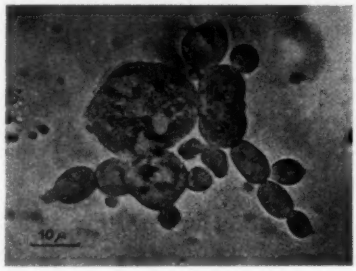

Fig. 4. Regeneration of new cells from a dense plasma formation. × 750

transfer these dense plasma formations to a new nutrient medium, we find that a membrane develops on their surface and that germination occurs in three days (Fig. 4). Cells result from this germination. The first generation looks very little like yeasts; but in later generations cells arise which correspond to the yeast cell in size and form. The yeasts originating in this way can easily be isolated from the medium and cultivated by a technique customary for fermenting organisms. All changes described have been recorded several times on microfilm by time-lapse photography, so that there can be no doubt about the right order of the separate evolutionary phases.

The majority of yeast strains developed by regeneration and isolated bear a morphological resemblance to the starting culture. Other strains were morphologically different and some of them have kept these deviations permanently. Among the latter is one with permanently polynuclear cells. Among the yeast strains obtained by regeneration, there are considerable variations (in comparison with the original strain) in biochemical properties, especially in the speed of fermentation and production of alcohol.

These observations show that cell fragments can regenerate new cells even among Ascomycetes. The mode of regeneration described here differs a great deal from those known hitherto; for (Fig. 5) the large amorphous and polynuclear plasma formations

Fig. 5. Scheme of the course of regeneration: plasma droplet, vacuolized plasmatic formation, dense plasma formation and regeneration proper

arise from the cell fragments before regeneration of yeast cells occurs.

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Meloidogyne acronea, a New Species of Root-Knot Nematode

Plants of *Sorghum vulgare*, variety Radar (a variety of sorghum developed in South Africa), were collected on a farm in the Vryburg District, Cape Province. The land had for a number of years previously been planted only to maize and sorghum. The roots of the plants collected were found to be galled, the galling being caused by a root-knot nematode the morphology and pathological behaviour of which reveal it to be a new species. The name *Meloidogyne acronea* is proposed for this species.

Measurements, which in all cases were of fixed specimens, were as follows:

Adult female: length, 840μ–950μ; width, 400μ–600μ; length of stylet, 11μ–13μ; basal bulbs of stylet, width, 4μ, length, 2μ. The dorsal gland aperture is 4μ from the base of the stylet. The excretory pore opens anterior to the median œsophageal bulb, usually about fourteen annules from the lip region.

Infective larva: length, 440μ–460μ, width, 14·6μ; $a = 32$, $b = 5{\cdot}8$, $c = 9{\cdot}2$; length of stylet, 10μ; basal bulbs, width, 2μ, length, 1μ; dorsal gland aperture, 3μ from base of stylet.

Adult male: length, from 1·66 mm.; width, 0·04 mm.; $a = 38$, $b = 16$; length of spear, 16μ–18μ; basal bulbs, width, 4μ–5μ, length, 2μ; spicules (measured on chord of their arc), 32μ–34μ.

Eggs: length, 90μ–96μ, width, 44μ–64μ.

Meloidogyne acronea n.sp. differs from the type species *M. exigua*, *M. javanica*, *M. incognita*, *M. arenaria* and *M. hapla*, described by Chitwood[1], in the following particulars:

The posterior portion of the body of the female is drawn out into a distinct rounded protuberance on which are situated vulva and anus. The perineal pattern formed by the transverse annulation is extremely obscure. The cuticle is tougher. The mature female does not invariably remain embedded in the tissues of the host but often bursts out, the egg sac being lost in the surrounding soil. In both male and female, although the basal framework supporting the head does not appear to be as heavily sclerotized, the stylet appears slightly more robust. The tip of the tail of the larva is more rounded. The phasmids in the male are post-anal.

A large number of eggs was produced (approximately 1,000) by females parasitizing sorghum and laid in a gelatinous matrix.

The lip region in both larva and male is without cross-striations.

The development of the immature infective life-stages appeared to be similar to that of other species. *M. acronea* was successfully transferred to beans and tomatoes, on which reproduction took place.

V. Coetzee

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Hatfield, Pretoria,
Union of South Africa.

[1] Chitwood, B. G., *Proc. Helminth. Soc. Wash.*, **16**, (2), 90 (1949).

Chromosome Numbers in Three Species of *Uronema*

As part of a cytological investigation of members of the Ulotrichales, the following chromosome counts have been made in three species of *Uronema*. They are the first records for the genus.

386/1	*Uronema bariowi* (Pringsheim) n.prov.	$n = 18$
386/2a	*U. confervicolum* Lagerh.	$n = 16$
386/3	*U. gigas* Vischer	$n = 18$

The serial numbers given above on the left are of the cultures used from the Cambridge Culture Collection of Algae and Protozoa.

Y. S. R. K. Sarma

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March 15.

Effects of Climate on Body Temperature and Respiration-rate of Buffaloes and Friesian Cattle

Observations were made on rectal temperature and respiration-rate of five groups of animals all kept in open sheds on the University Farm, Alexandria. Group I consisted of two buffalo cows and group II consisted of two Friesian cows, and all were in the same early stage of first lactation. The other three groups included two male calves each, from buffaloes, Friesians and native cattle. Readings of rectal temperature and respiration-rate were taken three times daily at 8.30, 11.30 a.m. and 2.30 p.m. on quietly standing animals on two days weekly for seven weeks from July 23 until September 9, 1955. Air temperature was recorded at the same intervals and ranged between 37·2° and 38·9° C.

There was a highly significant difference in body temperature and respiration-rate on different days and throughout the day due to different weather conditions between and during days. From Table 1 it will be seen that the mean body temperature and respiration-rate of the buffaloes was lower than those of the Friesians and the native cattle; the native calves, however, showed lower values than those of Friesian calves. The differences between all these results were highly significant.

Table 1

Comparison	Mean rectal temperature (° C.)	s.e.	d	Mean respiration-rate/min.	s.e.	d
Buffalo cows	38·39	0·038	−0·25	25·08	0·388	−7·68
Friesian cows	38·64	0·040		32·76	1·026	
Buffalo calves	38·34	0·027	−0·32	21·30	0·442	−8·96
Friesian calves	38·66	0·036		30·26	0·706	
Buffalo calves	38·34	0·027	−0·17	21·30	0·442	−4·56
Native calves	38·51	0·025		25·86	0·498	
Native calves	38·51	0·025	−0·15	25·86	0·498	−4·40
Friesian calves	38·66	0·036		30·26	0·706	

s.e., standard error; d, difference. All differences are significant at the 1 per cent level.

In buffaloes, the correlation coefficient between the average daily body temperature and air temperature for eight individuals was $r = +0{\cdot}10$ and non-significant. A similar estimate obtained for the respiration-rate and air temperature was $r = +0{\cdot}28$ and highly significant. However, the correlation between body temperature and respiration-rate was $r = +0{\cdot}20$, and this was statistically significant.

For the successive days, the repeatability between readings for respiration-rate of the buffalo stock was found to be 36 per cent. Regarding body temperature, buffaloes did not tend to follow any particular pattern in this respect.

K. A. Alim
I. A. Ahmed

Department of Animal Production,
Faculty of Agriculture,
University of Alexandria.
Nov. 26.

Scent of Otariids

Some years ago I was engaged in an examination of the small, almost residual, herd of fur seal (*Arctocephalus australis*) in the Falkland Islands. In the course of it a number of animals were killed, among them several bulls, or 'wigs' in the sealer's vocabulary. After handling the bulls' skins there was left on the unwashed hands a general, not unpleasant, 'seal' smell; but after washing there remained a definite perfume rather resembling the odour emitted by the common civet when it is pleasurably excited. On one bright, sunny day, therefore somewhat warm on the rocks, I passed a few feet away from and to leeward of a bull and I was able to observe the pleasant perfume, which was definitely air-borne. If I remember rightly, this seal was a little angry. The seals on which these observations were made were all met with in summer, that is, over the rather extended breeding season.

At various times I have handled fresh skins of the adult male of the southern sea lion (*Otaria byronia*) and on them I have observed a rather stronger and ranker odour which was undoubtedly that of the animals themselves, not of the generally insanitary terrain. This scent contained a suggestion of sweetness in it.

It seems possible that a distinctive odour produced by the adult males of the Otariidae, a family in which the bull occupies territory and waits for cows to come ashore, may be of value to the species as a direction indicator to the cows. We cannot estimate the distance at which the odour could be observed by the animals—it may be greater than we think.

It would be interesting to know if other workers on the mammals have made observations on scent, characteristic, specifically or otherwise, of the subjects. Some of us, at least, have been from childhood familiar with the 'smell of mice'.

J. E. Hamilton

Ross House,
Stanley,
Falkland Islands,
South Atlantic.
Dec. 24.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, May 14

CHADWICK TRUST (in the Barnes Hall of the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 5 p.m.—Dr. Huntington Williams (U.S.A.): "The Influence of Chadwick on American Public Health"* (Chadwick Public Lecture).

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Mr. A. G. N. Weddell: "Problems of Cutaneous Sensation".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. F. S. Bodenheimer (Jerusalem): "The Growth of Knowledge of Animals in Palestine from Palæolithic Times".* (Further Lectures on May 16 and 17.)

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "An Elementary Presentation of the Principles of Magnetism and Electromagnetic Induction, with Demonstrations". Opening Speaker: Prof. K. A. Hayes.

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Prof. David V. Glass: "Some Aspects of the Development of Demography". (Second of three Cantor Lectures on "Recent Studies of Sociology.")

INSTITUTE OF METAL FINISHING (at the Northampton Polytechnic, St. John Street, London, E.C.1), at 6.15 p.m.—Mr. C. H. Rumble: "The Processing of Gramophone Matrices".

Monday, May 14—Thursday, May 17

PHYSICAL SOCIETY (in the Royal Horticultural Society's Old and New Halls, Westminster, London, S.W.1)—40th (1956) Annual Exhibition of Scientific Instruments and Apparatus.

Discourses and Demonstration Lectures.

Monday, May 14

At 6.15 p.m.—Mr. H. G. Jenkins: "Recent Developments in Light Sources".

Tuesday, May 15

At 6.15 p.m.—Prof. H. Lipson: "The Production of Images of Chemical Molecules".

Wednesday, May 16

At 6.15 p.m.—Mr. G. G. Gouriet: "Colour Television—Considerations which have led to Recent Trends".

Tuesday, May 15

WRIGHT–FLEMING INSTITUTE OF MICROBIOLOGY (at St. Mary's Hospital Medical School, London, W.2), at 5 p.m.—Dr. W. E. van Heyningen: "Recent Trends in Research on Bacterial Toxins"* (Almroth Wright Lecture).

IRON AND STEEL INSTITUTE (at the Royal Institution, Albemarle Street, London, W.1), at 6.30 p.m.—Mr. James Mitchell: Bessemer Centenary Lecture.

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Dr. A. Buchanan Barbour: "Medical Aspects of Flight Comfort and Efficiency".

UNIVERSITY OF LONDON (at the Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1), at 8.15 p.m.—Prof. V. G. Childe: "The Primary Spread of Neolithic Farmers in Temperate Europe".* (Third of seven lectures on "The Dawn of European Civilization—Thirty Years After". Further Lectures on May 22, 29, June 5 and 12.)

Wednesday, May 16

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Commander C. G. Mayer, U.S.N.R.: "Electronic Photography" (Peter Le Neve Foster Lecture).

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. R. W. R. Rutland: "Structure, Metamorphism and Granite Emplacement in the Sokunvatn Area of Northern Norway"; Dr. W. J. Phillips: "The Criffel–Dalbeattie Granodiorite Complex" (to be read by Prof. A. Wood).

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. G. P. B. Naish: "The James Cook Exhibition at Greenwich"; Mr. C. H. Gibbs-Smith, Mr. D. N. Harrison and Mr. C. S. Durst: "Ballooning".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Scientific Papers.

ROYAL SOCIETY OF MEDICINE, COMPARATIVE MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 5 p.m.—Annual General Meeting; followed by a Discussion on "Learning in Man and Animals".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mrs. Dorothy Cole and Mr. J. E. G. Utting: "Estimating Expenditure, Saving and Income from Household Budgets".

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. K. W. Keohane and Dr. W. K. Metcalf: "Microspectrophotometry of Hæmoglobin Using the Burch Microscope".

Wednesday, May 16—Thursday, May 17

IRON AND STEEL INSTITUTE (at the Royal Institution, Albemarle Street, London, W.1, and at 4 Grosvenor Square, London, S.W.1)—Eighty-Seventh Annual General Meeting.

Wednesday, May 16

(At the Royal Institution). At 11.45 a.m.—Prof. N. F. Mott, F.R.S.: Ninth Hatfield Memorial Lecture.

Thursday, May 17

INSTITUTION OF MINING AND METALLURGY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 4 p.m.—Annual General Meeting. 5.15 p.m.—Prof. C. W. Dannatt—Presidential Address.

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. J. C. Swallow: "Research in the Plastics Division of Imperial Chemical Industries Limited".

LONDON MATHEMATICAL SOCIETY (at the University, Nottingham), at 5 p.m.—Dr. E. F. Collingwood: "Cluster Sets and Prime Ends".

ROYAL AERONAUTICAL SOCIETY (at the Royal Institution, Albemarle Street, London, W.1), at 6 p.m.—Sir William Farren, F.R.S.: "The Aerodynamic Art" (44th Wilbur Wright Lecture).

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. B. B. Waddy: "Organization and Work of the Gold Coast Medical Field Units".

Friday, May 18

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 425, Birkbeck College, Malet Street, London, W.C.1), at 1 p.m.—Mr. R. N. Tronchin-James: "The Personality Structure of Senior Industrial Executives"; Mr. V. W. Wilson: "Some Personality Characteristics of Industrial Executives".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

COMPUTER (with G.C.E. with mathematics at "A" level, or equivalent qualifications) in the Scientific Department in London, to work with scientists engaged on a variety of mathematical and statistical problems—National Coal Board, Staff Department, Hobart House, London, S.W.1, quoting SS/265 (May 18).

SENIOR LECTURER IN PRODUCTION ENGINEERING, and a SENIOR LECTURER IN APPLIED THERMODYNAMICS—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (May 18).

LECTURER or ASSISTANT (Grade B) (with special qualifications in plant physiology) IN BOTANY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (May 23).

ASSISTANT LECTURER IN PURE MATHEMATICS—The Registrar, The University, Nottingham (May 26).

LECTURER or ASSISTANT LECTURER IN ZOOLOGY—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1 (May 26).

ASSISTANT LECTURER (with special qualifications in physical chemistry) IN CHEMISTRY—The Registrar, The University, Manchester (May 28).

LECTURER (with special experience in virus diseases) IN MICROBIOLOGY—The Secretary, The Queen's University, Belfast (May 30).

LECTURER (with research experience in aeronautics, preferably in the field of high speed aerodynamics) IN AERONAUTICAL ENGINEERING—The Secretary, The Queen's University, Belfast (May 30).

ABSTRACTOR, Scientific Assistant grade (with a degree in agriculture or natural science, a knowledge of languages, and the ability to write clear concise English), for duties which mainly consist of abstracting world scientific literature on grassland and field crop research—The Director, Commonwealth Bureau of Pastures and Field Crops, Hurley, near Maidenhead, Berks (May 31).

ASSISTANT LECTURER IN PHYSICS—The Registrar, University College of North Staffordshire, Keele, Staffs (May 31).

ASSISTANT LECTURER (with a good honours degree) IN PURE MATHEMATICS—The Registrar, King's College, Strand, London, W.C.2 (May 31).

JUNIOR LECTURER (medically qualified graduate) IN PHARMACOLOGY—The Dean, Medical College of St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (May 31).

LECTURER IN PHARMACEUTICS, and a LECTURER IN PHARMACEUTICAL CHEMISTRY, at Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C.1 (May 31).

LECTURER (with an honours degree in chemistry with considerable research experience and special interests in physical chemistry) IN PHYSICAL CHEMISTRY—The Registrar, College of Technology, Manchester 1 (June 1).

PHYSIOLOGIST or BIOCHEMIST (preferably honours science graduate with a knowledge of, or willingness to learn, foreign languages, especially German) to join a team on information work and abstracting—The Director, Commonwealth Bureau of Dairy Science, Shinfield, Reading (June 1).

PRINCIPAL OF THE WELLINGTON TECHNICAL COLLEGE, New Zealand, to be in charge of a technical high school and a large number of day and evening technical classes, and act as Secretary to the Board of Managers—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (June 1).

LECTURER IN PHYSIOLOGY at the University College of the West Indies—The Secretary, Senate Committee on Colleges Overseas in Special Relation, University of London, Senate House, London, W.C.1 (June 4).

CHAIR OF CHEMISTRY—The Registrar, University College, Singleton Park, Swansea (June 5).

LECTURER IN EDUCATION at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 7).

PHYSICISTS and ELECTRICAL ENGINEERS (with a first- or second-class honours degree or equivalent in physics or electrical engineering) at the Ministry of Supply Radar Research Establishment, Malvern, Worcs, for research and development work, mainly on radar and electronic equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.148/6A (June 8).

UNIVERSITY LECTURER (with an honours degree in pure science with organic chemistry and biochemistry as principal subjects) IN ANIMAL NUTRITION—The Secretary, School of Agriculture, Downing Street, Cambridge (June 8).

LECTURER or ASSISTANT LECTURER (with special qualifications in organic chemistry) IN CHEMISTRY—The Registrar, The University, Manchester 13 (June 11).

LECTURER IN GEOLOGY with responsibility for mineralogy and petrology to special degree standard, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (June 15).

CHAIR OF PHILOSOPHY at Canberra University College, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (June 23).

LECTURER or SENIOR LECTURER (with a university degree in civil and/or agricultural engineering, and some interest in structures and building planning) IN AGRICULTURAL ENGINEERING at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 30).

SENIOR RESEARCH FELLOW (with experience in electronic physics) for the development, under the direction of Prof. G. Porter, of pulse and rapid recording techniques for the study of fast reactions—The Registrar, The University, Sheffield (June 30).

RESEARCH STUDENTS (with the degree of Bachelor or Master of a British university other than Manchester) IN SCIENCE—The Registrar, The University, Manchester 13 (July 1).

ASSISTANT EXPERIMENTAL OFFICER (graduate in chemistry or biology, or both) IN THE UNIT FOR THE STUDY OF BIOCHEMICAL PROBLEMS IN RELATION TO FISHERIES, for duties which will include the estimation of vitamins in, and histology and culture of, aquatic organisms—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting Ref. 56/6.

ENTOMOLOGICAL FIELD OFFICER (with Inter.B.Sc., and between the age of 24 and 45) IN THE MEDICAL DEPARTMENT, Kenya Government, to perform laboratory duties and assist with entomological research (including safari work)—Crown Agents, 4 Millbank, London, S.W.1, quoting M3A/43289/NF.

LABORATORY ASSISTANT FOR SCHOOL PHYSICS LABORATORY—Mr. P. Bateman, Highgate School, London, N.6.

LECTURER or ASSISTANT PROFESSOR IN THE DEPARTMENT OF MATHEMATICS, Joint Faculty of Arts and Science at Dalhousie and King's Universities—The Dean of Arts and Science, Dalhousie University, Halifax, Nova Scotia, Canada.

MATHEMATICIAN (preferably with a knowledge of electronics) to assist in the operation and development of an electronic digital computer used in the Statistics Department—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

PHYSICAL CHEMIST (graduate or equivalent), to take charge of the Polymer Characterization Section—The Director of Research, British Rubber Producers' Research Association, 48 Tewin Road, Welwyn Garden City, Herts.

PHYSICIST IN THE RADIOTHERAPY DEPARTMENT, to work with staff of the Department on a research programme on moving beam X-ray therapy dosage—Hospital Secretary, Royal Northern Hospital, Holloway Road, London, N.7.

SCIENTIFIC OFFICER (Control) (with a good honours degree in either zoology, entomology, agricultural chemistry or physics or allied subjects) IN THE INTERNATIONAL RED LOCUST CONTROL SERVICE, Abercorn, Northern Rhodesia, to carry out operational research on the chemical control of red locusts in the outbreak areas in Tanganyika and Northern Rhodesia—The Crown Agents, 4 Millbank, London, S.W.1, quoting Ref. M3B/43298/TA.

SENIOR LABORATORY TECHNICIAN (with experience in laboratory management and glass-blowing) IN THE SCIENCE DEPARTMENT—The Principal, Medway College of Technology, Horsted, Maidstone Road, Chatham.

SENIOR TECHNICIAN (with experience in experimental physiology) IN PHYSIOLOGY—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1.

SPECIALIST (Chemist) (with at least a second-class honours degree in chemistry, preferably inorganic or physical chemistry, followed by one year's postgraduate training or approved experience in agricultural chemistry including statistical methods) IN THE DEPARTMENT OF AGRICULTURE, Gold Coast Local Civil Service, for duties which are concerned with the cultivation of cocoa and include planning and execution of research into soil fertility, field work in connexion with the use of inorganic manures, and the administration of staff, equipment and laboratory—Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/13/022.

VETERINARY BACTERIOLOGIST (expert in the preparation of serums and vaccines) IN THE VETERINARY LABORATORY of the Directorate General of Veterinary Services, Iraq—The Ministry of Labour and National Service (A.S.12), Almack House, 26–28 King Street, London, S.W.1, quoting A.12/IRQ/162/ME.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Animal Husbandry: a Series of Lectures delivered during the 1954–55 Session under the Devon County Agricultural Association Lectureship. By Prof. J. E. Nichols. Pp. iii+40. (Newton Abbot: Seale-Hayne Agricultural College, 1956.) 4*s*. [222

British Broadcasting Corporation: Engineering Division. Monograph No. 5: Reproducing Equipment for Fine-Groove Records. By G. V. Buckley, W. R. Hawkins, H. J. Houlgate and J. N. B. Percy. Pp. 20. (London: British Broadcasting Corporation, 1956.) 5*s*. [222

Scottish Home Department. Freshwater and Salmon Fisheries Research. No. 11: Records of Salmon and Sea Trout caught at Sea. By K. H. Balmain and W. M. Shearer. Pp. 12. (Edinburgh: H.M. Stationery Office, 1956.) 3*s*. net. [222

University of London. University College Annual Report, 1954–1955. Pp. 81. (London: University College, 1956.) [242

University of Nottingham. Plant Growth and the Weather. By Prof. F. L. Milthorpe. (An Inaugural Lecture delivered at the University of Nottingham, 14th October, 1955.) Pp. 12. (Nottingham: The University, 1956.) 1*s*. 6*d*. [242

Carnegie Trust for the Universities of Scotland. Fifty-Fourth Annual Report (for the year 1954–1955) submitted by the Executive Committee to the Trustees on 20th February 1956. Pp. iv+72. (Edinburgh: Carnegie Trust for the Universities of Scotland, 1956.) [242

Aluminium Development Association. Research Report No. 29: Local Instability Problems of Light Alloy Struts. By Dr. P. S. Bulson. Pp. 75. 7*s*. 6*d*. Research Report No. 30: Investigations into the Optimum Dimensions for Countersunk Points for Aluminium Rivets, particularly for Marine Work. By A. W. Brace and Dr. A. B. Watts. Pp. 28. 7*s*. 6*d*. (London: Aluminium Development Association, 1955.) [242

Other Countries

Research Bulletin of the Panjab University. No. 72 (Zoology): The Morphology of Chromosomes in *Lacoctrephes Maculatis* Fabr. (Hemiptera-Heteroptera). By G. P. Sharma and Ram Parshad. Pp. 67–72. Rs. 1/-/-. No. 73 (Chemistry): Potentiometric Determinations of Organic Compounds by Iodine Monobromide in Non-Aqueous Solvent. By Balwant Singh and Mohan Singh. Pp. 73–90. Rs. 2/8/-. No. 74 (Zoology): On the Origin of the Golgi Dictyosomes from the Mitochondria and Acrosome Formation in the Spermatogenesis of the Slug *Anadenus Altivagus* (Theobald). By Vishwa Nath and Harish Chander Chopra. Pp. 91–100. Rs. 1/12/-. No. 75 (Zoology): Studies in Reptilian Spermatogenesis. 1: Spermatogenesis of the Chequered Water Snake, *Natrix p. piscator* Schneider, with some Observations on the Spermatids of the Krait and the Cobra. By Bhupinder Nath Sud. Pp. 101–117. Rs. 3/-/-. No. 76 (Zoology): Spermatogenesis of White Rat with Observations under the Phase-Contrast Microscope. By Miss Balbir Kaur Dhillon. Pp. 119–130. Rs. 2/4/-. No. 77 (Zoology): Spermatogenesis of the Domestic Duck with Observations on Living Material under the Phase-Contrast Microscope. By Brij L. Gupta. Pp. 131–140. Rs. 2/4/-. No. 78 (Chemistry): Volumetric Studies in Oxidation-Reduction Reactions. 6: Oxidation with Chloramine-T Iodine Cyanide Method. By Balwant Singh and Krishan Chander Sood. Pp. 141–144. Rs. 0/12/-. (Hoshiarpur: Panjab University, 1955.) [222

Smithsonian Miscellaneous Collections. Vol. 131, No. 3: Synonymical Notes on Neotropical Flies of the Family Tabanidae (Diptera). By G. B. Fairchild. Pp. ii+38. (Publication 4225.) (Washington, D.C.: Smithsonian Institution, 1956.) [242

Smithsonian Institution. Report of the Secretary and Financial Report of the Executive Committee of the Board of Regents for the year ended June 30, 1955. Pp. ix+173+7 plates. (Publication 4230.) (Washington, D.C.: Government Printing Office, 1956.) [242

Tanganyika: Geological Survey Department. Bulletin No. 27: The Geology of the Songwe-Kiwira Coalfield, Rungwe District. By D. A. Harkin. Pp. vii+33+9 plates. (Dar-es-Salaam: Government Printer, 1955.) Shs. 7/50. [242

Chicago Natural History Museum. Fieldiana: Geology. Vol. 10, No. 22: The Carboniferous Gastropod Genus *Glabrocingulum* Thomas. By Robert E. Sloan. Pp. 275–282. 35 cents. Vol. 10, No. 23: The Paragould Meteorite. By Sharat Kumar Roy and Robert Kriss Wyant. Pp. 283–304. 75 cents. Vol. 12, Nos. 1–4: Pennsylvanian Invertebrates of the Mazon Creek Area, Illinois. By Eugene S. Richardson, Jr. Pp. 76. 2 dollars. Fieldiana: Zoology. Vol. 34, No. 34: Coral Snakes of the Genus Micrurus in Columbia. By Karl P. Schmidt. Pp. 337–360. 35 cents. Vol. 34, No. 35: On Some Small Collections of Inland Shells from South America. By Fritz Haas. Pp. 361–388. 1 dollar. (Chicago: Chicago Natural History Museum, 1955.) [242

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